LUMBER REQUIREMENTS *for* Nonfarm Residential Construction

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Lumber Requirements for Nonfarm Residential Construction

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The Forest Survey

NATIONAL welfare, both industrially and socially, rests heavily on permanent forest-land management, since roughly one-third of our productive land has no other important prospective use than for growing timber and the livelihood of 10 million people is directly affected to some extent by the employment afforded in the harvesting, transporting, and distributing of the forest products from that land. Obviously forest-land management must rely on a long-time economy backed by facts as to location, area, and condition of existing and prospective forest lands, depletion and growth, and present and probable future requirements for forest products. With a view to obtaining such facts, Congress by the McSweeney-McNary Forest Research Act of May 22, 1928, authorized a Nation-wide forest survey.

The Forest Survey, as constituted under that act, is obtaining essential field information and through interpretation thereof is aiding in the formulation of guiding principles and policies fundamental to a system of planned management and land use for each forest region and for the Nation.

The fivefold purpose of the Forest Survey is (1) to make a field inventory of the present supply of timber and other forest products; (2) to ascertain the rate at which this supply is being increased through growth; (3) to determine the rate at which it is being diminished through industrial and domestic uses, windfall, fire, disease, and other causes; (4) to determine the present consumption and the probable future trend in requirements for timber and other forest products; and (5) to interpret and correlate these findings with existing and anticipated economic conditions, as an aid in the formulation of both private and public policies to guide the most effective and rational use of land suitable for forest production.

The field inventory of resources and analysis thereof are being carried out entirely by the forest experiment stations in their respective regions. The requirements study is handled on a national basis from Washington with some assistance from the experiment stations. This difference is explained by the fact that the resources of each region are independent of every other region. Requirements, on the other hand, are not localized. This study will involve a number of separate reports, similar to the present one, covering primary forest products and including lumber for farm construction, miscellaneous construction, and factory use; naval stores, hardwood distillation, and pulpwood; mine timbers, ties, posts, poles, and piling; shingles, fuel wood, and minor forest industries such as cooperage, excelsior, and veneer.

Contents

Introduction

LUMBER used in nonfarm residential construction is logically the first consideration in surveying the Nation's timber requirements, since this field of construction accounts for so large a part of our total lumber consumption—roughly one-third during the decade 1920–29—and lumber constitutes so large a drain on our forests. Incidentally, residential construction looms large as an aid in solving the unemployment problem.

Nonfarm residential construction here includes all housing other than farm. This classification is at once more convenient and more satisfactory for the purposes of this survey than the Bureau of the Census classification, which sets up a rural nonfarm class between the urban community of 2,500 and the farm.

Although residential construction includes both new buildings and repair, new construction makes up so large a part of the total (about 85 percent) that it receives major attention. Furthermore, it is measurable in definite volume units and is itself an indicator of probable trends as they may affect repairs.

The analysis of residential construction involves a determination of number of living units required, size of units, board feet of lumber per unit of volume, and the factors affecting trends in each case. With these data in hand, it becomes possible not only to estimate requirements on the basis of present conditions, but also to anticipate changes in volume of construction and lumber requirements that are likely to follow changes in any of the controlling factors.

In the process of accumulation of these data, Bureau of the Census publications were the source of figures on past trends in population and persons per family. Thompson and Whelpton forecasts were used as estimates of prospective future population. Number of new dwelling units built and value of repairs were taken from permit records a compiled by the Bureau of Labor Statistics, Department of Labor. These compilations were made for 257 cities of 25,000 population, beginning 1920. Since 1932 the compilations have included cities of 10,000 population and the number of cities has been increased to some 1,600. Construction trends prior to 1920 are based on a study of building cycles by Riggleman.[1]

Field surveys supplemented the data obtained from such sources. These included an examination of permit records of a number of selected cities for data on size of buildings and type of construction, and a questionnaire to get similar data from cities not visited. From bills of material obtained from contractors and builders, factors were computed to convert cubic-foot volume to board feet of lumber. Sample surveys of demolition were made in Washington, D. C., Portland, Oreg., and Oakland, Calif., to ascertain age at demolition and reasons for demolition. The Real Property Inventory made by the Department of Commerce in 1934[2] was helpful in the analysis of age and type of construction of existing structures.

The survey in the far West was carried out by the various forest and range experiment stations of the Forest Service as follows: In California, by H. R. Josephson under the supervision of C. L. Hill of the California station at Berkeley; in Washington and Oregon by J. Elton Lodewick of the Pacific Northwest station at Portland, Oreg.; and in Montana, Idaho, and eastern Washington by C. N. Whitney of the Northern Rocky Mountain station, at Missoula, Mont.

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[1] RIGGLEMAN, JOHN R. BUILDING CYCLES IN THE UNITED STATES 1875–1932. Jour. Amer. Stat. Assoc. 28: 174–183, illus. 1933.

[2] UNITED STATES BUREAU OF FOREIGN AND DOMESTIC COMMERCE. REAL PROPERTY INVENTORY. 65 v. 1934.

Prospective Volume of Residential Construction

Need as Distinct From Demand for New Construction

ESTIMATED prospective residential construction is based on the apparent need for new accommodations and the probable conversion of such need into demand.

Need here includes accommodations necessary to house the increase in families and to replace accommodations which for one reason or another pass out of residential use. Increase in families is accounted for by both increase in population and decrease in number of persons per family. Replacements are for accommodations destroyed by fire and storm, demolished to make way for new construction, converted to other uses, or vacant and awaiting such disposition.

Need is more or less rigid. That is, customs or habits do not change rapidly or violently. Certain changes may be seen to be taking place, perhaps in materials, in style, in size of accommodations, etc., but the total effect is a gradual change, if any, in the relation between increase in families and housing units needed. On the other hand, demand is elastic. A need for housing, measured by established standards as to living accommodations, may be set up by a certain increase in population, but unfavorable economic conditions, a war emergency, or some other abnormal condition may retard the conversion of this need into demand. Excess population may be taken care of temporarily by doubling up or may be housed in dwellings that would normally have passed out of use. As economic conditions change, this lag in demand may be taken up, in part or in whole, and be converted into construction.

Increase in population has always been the prime factor in the need for new residential construction, and prior to 1930 this so completely obscured all other factors as to make consideration of the others unnecessary. Since 1929, however, population increase has been falling off rapidly. The prospective increase for the decade 1930–39 is only about half what it was from 1920 to 1929, and the trend is expected to continue either to a point of stability or to a declining total population. Estimates of maximum population which appear to be in favor at present vary between 140 million to be reached about 1960 and 153 million to be reached about 1980. The estimates of prospective residential construction to 1949 employed here are for a maximum population midway between the two.

The change in population trend has directed somewhat belated attention to the second factor in increase in families, namely, decrease in number of persons per family. Persons per family has been declining quite persistently for half a century at a rate of about 5 percent a decade. Obviously the factor becomes more important as the total population increases. With 1930 population double that of 1890, the same decrease in persons per family has twice the effect that it had then. During the decade 1930–39, decrease in size of family should have about equal influence with that of population increase in determining need for additional living units. Should population become stable, decline in persons per family would still cause an increase in families to be housed; but a decline in population would counteract that factor.

Another factor that in the past has appeared negligible in comparison with population increase is that of replacement. Probable life of dwellings has had little consideration, since with more than half of our dwellings less than 50 years old, any convenient life period could be assumed without appreciable effect upon the estimate of future new construction. But this condition also is changing. Replacement will increase with age, but its relative importance will increase even faster, eventually displacing other factors when the increase in families stops. Replacement and abandonment need

not take place in the same locality. Migration of families, bringing about increases in some localities and decreases in others, may simply be regarded as abandonment in the one place and replacement in the other.

Determination of Need

The permit records compiled by the Bureau of Labor Statistics for the 257 cities of 25,000 population represent approximately half the nonfarm population of the country. Population and family data for these cities are available from census publications for the years 1920 and 1930. These two records make possible an accurate analysis of a decade of actual construction in relation to increase in population and families. For one reason or another, 14 of the cities—none having appreciable weight in the total representation—had to be discarded. The remaining 243 cities were arranged in order of percent increase in families and then grouped by tens, except group 25, which contained 3 cities. Averages for these groups are plotted in figure 1, the vertical lines representing percent increase in population and the vertical bars percent increase in families. The boxed inset of the detail of group 17 shows what the chart would look like if individual cities were plotted.

In order to permit direct comparison of one city with another or of one group with another, all factors are expressed in terms of 10,000 population.

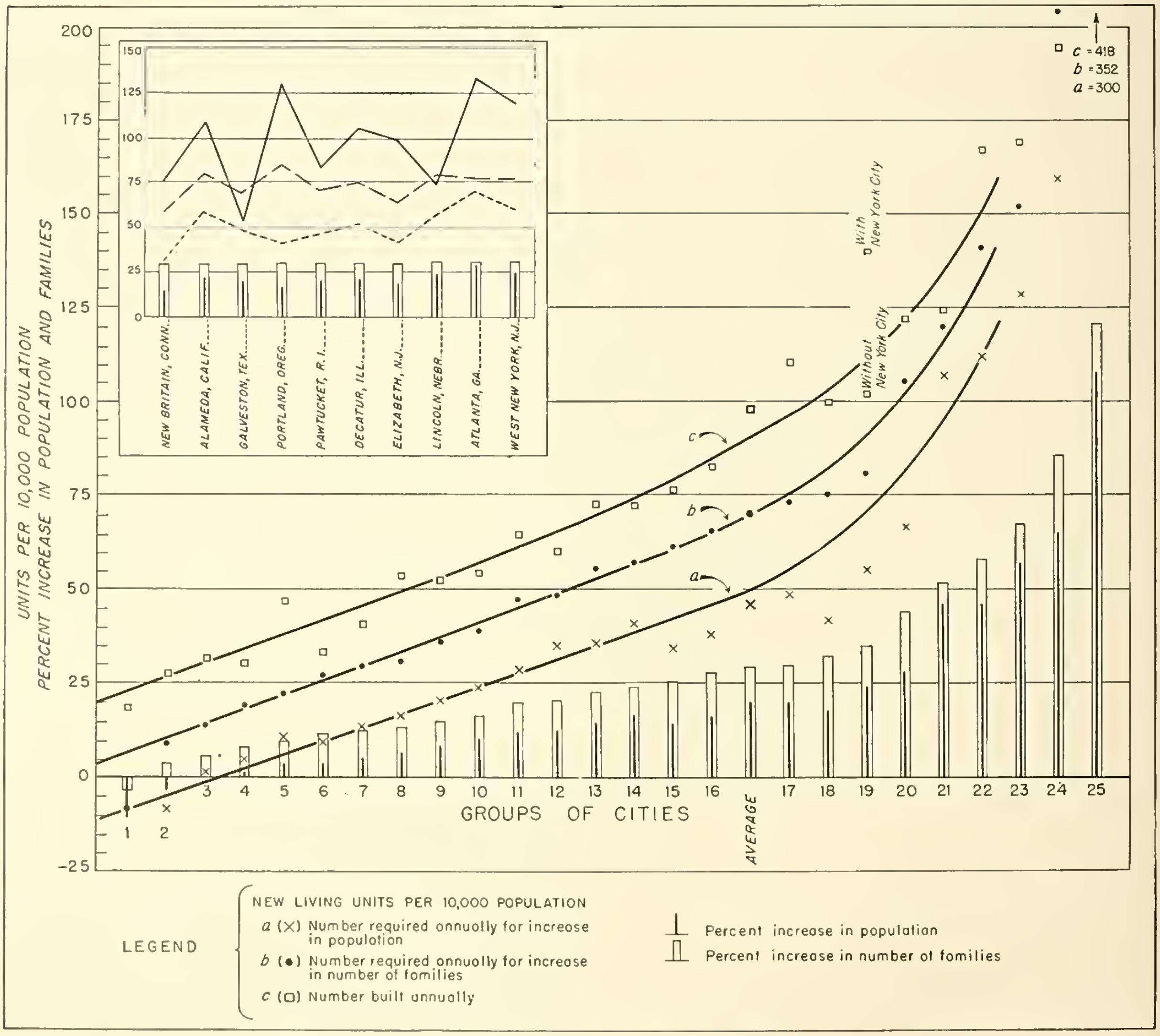

FIGURE 1.—*Relation of new residential construction to increase in number of families for 243 cities of 25,000 population and over, 1920 to 1929, arranged in 24 groups of 10 and 1 group of 3 by percent increase in families. New York City falls in group 19.*

For example, an increase of 25 percent in population, over a decade, for a city of 100,000 having 4 persons per family unit, is equivalent to a need for 625 new units per 10,000 population for the decade, or 62½ units annually. Curve *a* represents the increase in population converted to living units required annually for 10,000 population. Similarly curve *b* represents increase in families in terms of living units required annually per 10,000 population. Curve *c* indicates actual construction in units per 10,000 population.

The difference between *a* and *b* represents the construction need due entirely to decrease in persons per family, and shows this factor to have been fairly independent of population increase below about 20 percent. The difference between *b* and *c* is a combination of several factors, principally change in vacancy conversions and demolitions, factors on which there are very few data.

There was a serious shortage of accommodations as of 1920, with practically no vacancy, whereas in 1929 there was a surplus vacancy, or a vacancy higher than the 5-percent normal. Such data as are available suggest this change in vacancy accounts for the larger portion, if not all, of the spread between *b* and *c*.

Conversions and demolitions tend to counteract one another, that is, conversions add to the number of living units available and demolitions take away. From such meager data as were available for the period 1920–29, the two apparently balanced. A conversion equal to 4.5 units per 10,000 population was arrived at from conversion records for a number of cities included in reports of the Bureau of Labor Statistics for a number of years.

Demolition was originally estimated at 5 units per 10,000 population from records for Denver (1931), for Washington, D. C. (1929), for Springfield, Mass. (1929–30), for Springfield, Ohio (1932), and for Philadelphia (1923–29). The Bureau of Labor Statistics has made a special survey of building-permit records of 813 cities for 1929–35, including demolition data when available. An average arrived at from reports for 80 cities does not change the writer's estimate of 5 per 10,000.

Very little is known about replacements; but as population approaches stability, replacement will become the prime factor in determining needed residential construction, and it is accordingly imperative to give this subject very careful study. Such replacements as have occurred are necessarily associated with rapid growth and may not be a safe index of probable future replacement age. Other factors than age and rapid growth will be discussed later on. Such uncertainty as there may be with regard to future replacement on a long-time basis is for the present compensated by the unlikelihood that it will be an important factor in the period covered by this forecast.

The fact that any forecast is subject to unforeseeable changes is the primary reason for an analysis such as is represented in figure 1. With the factors segregated, correction may be made at any time for unusual destruction by fire or storm, a change in immigration policy that affects population trend, reversals of farm to city migration, or other unexpected changes in any factor.

Population trend is forecast with considerable confidence, subject to possible unexpected epidemics, wars, restrictions on immigration, or other major changes. The forecasts now are for a population increase of approximately 9 million from 1930 to 1939 and 7 million from 1940 to 1949. It is assumed that these increases will be nonfarm, with little change in farm population.

Nonfarm population in 1930 was 92.5 million. An increase of 9 million is approximately 10 percent, which is the same as for group 10 in figure 1. Construction for group 10 was 56 units annually per 10,000 population. Fifteen units, the difference between lines *b* and *c*, for vacancy, demolition, and conversion are out of the picture for the current decade, leaving 41 units as necessary for prospective increase in families to be housed. But with persons per family decreasing 5 percent per decade, a corresponding correction must be made to readings from figure 1, which raises the 41 units to 43. Another 2 units are necessary to maintain a normal vacancy of 5 percent in the total available housing after the new units are added. Thus the prospective annual construction need in the present decade would be 45 units per 10,000 population, or approximately 420,000 units annually for the total nonfarm population, as compared to 712,000 units annually during the last decade.

The anticipated increase of 7 million from 1940 to 1949 is 7 percent of the 102 million nonfarm population estimated for 1940. Following the procedure used above, the prospective needed construction from 1940 to 1949 would be 43 units per 10,000 population, or 440,000 units annually for the nonfarm population of 102 million.

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Cyclical Movement of Demand

Need for new living units, as determined by increase in nonfarm families and measured by decades, increased at a fairly uniform rate up to 1930. In all probability it will continue to move uniformly after adjustment for a sharp change in direction caused by declines in immigration about 1930 and in farm-to-city migration during the industrial prosperity of the twenties. Such causes are exceptional, however, and subsequent sharp breaks in theoretical need are likely to occur only from equally exceptional causes.

On the other hand, estimates of 420,000 and 440,000 units of needed construction annually do not imply that the need will be converted into demand or actual construction at a uniform annual rate. As previously stated, demand or actual construction is flexible and moves in cycles, and a study of past cycles is very helpful to an understanding of present construction trends.

The compilation from permit records by the Bureau of Labor Statistics of the number of new units annually goes back to 1920. This gives approximately one construction cycle, but a longer period is necessary to study the cyclical movement. Fortunately, residential construction follows more or less the general trend for all building (going a little higher on the upswing and a little lower on the downswing), and records of total expenditure for construction go back over several cycles. Figure 2 shows a very close similarity in trend from 1921 to 1934. The similarity is not always so close, but a general agreement is logical, since residential construction is so large a part of the total, and since the same factors operate in both. Assuming that such is the case, the cyclical movement of total construction can be taken to represent a corresponding movement in residential construction. This record from 1875 is plotted in figure 3.

In figure 3, curve *a* represents actual construction from 1900 to 1932 for 52 cities, based on Riggleman's analysis already referred to, and includes 4 cities for which records were available beginning with 1875. The number was increased at intervals up to 1900. Expenditure figures have been converted into 1913 dollars. In the present analysis the per capita figures of the original data were applied to the population of the 52 cities to arrive at total construction for all these cities throughout the period. The solid triangles indicate construction totals by decades, or annual averages by decades, depending on which scale is used, and are in dollar values. The open squares similarly indicate new dwelling units necessary to care for increases in number of families. The two have practically identical trends and a relationship of approximately one family unit to $5,000 of total construction (1913 dollars).

Curve *b*, which represents need or requirements in family units, falls very close to a straight-line trend, corresponding to the almost uniform increase in families by decades. Average volume of construction follows the same trend and the two show a close agreement up to 1899. Construction was deficient for the two decades 1900–1909 and 1910–19. A balance was reached about 1915 that is not indicated on the chart. Consequently, the total deficiency as of 1919, although it is the sum of the deficiencies for both decades, was actually accumulated after 1915. This deficiency explains the serious housing shortage in 1920 already mentioned. Industrial prosperity released the accumulated need with an upswing in volume of construction which ended in an excess of family units as of 1929.

The cyclical movement in figure 3 is projected beyond 1930 by assuming the forecasted 16.5-percent increase in families to 1940 and a 13-percent increase from 1940 to 1950. A 16.5-percent increase to 1940 for the 52 cities is 1,300,000 families. After deducting an estimated surplus of 110,000 units as of 1930, this would amount to a need for 1,200,000 new units for these cities, and the equivalent total construction would be $6,000,000,000. The cycles, however, do not coincide with the decades. The current cycle, if it is to be of average duration and starting with 1933 or 1934, should extend to about 1952 with the crest about 1942.

The broken-line extension on figure 3 is a hypothetical pattern for estimated total construction to 1952. Applying this pattern to the 8,600,000 units forecast for the two decades 1930–49 (based on fig. 1), the prospective annual construction for the whole country, by number of living units, is approximately as presented in table 1. The cycle shown by the curve in figure 3 starts at such a low point that the upswing may be more like that after 1918 than that after 1879 or 1900. In other respects it seems likely that the present cycle might be more like the earlier cycles than the last one; that is, the swings from low to high and back again should be less for this cycle than for the last one.

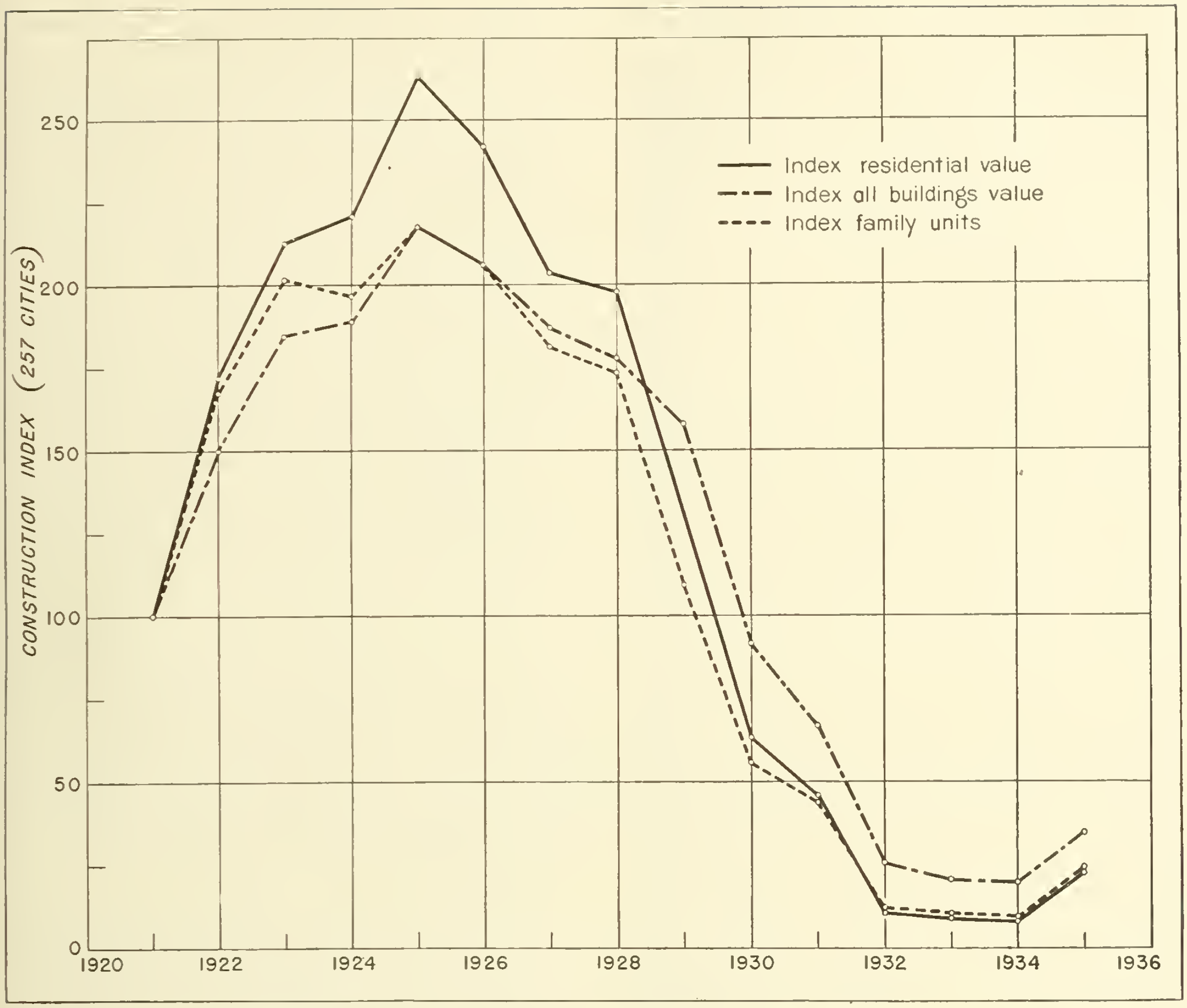

FIGURE 2.—*Total construction and residential construction 1921 to 1925.*

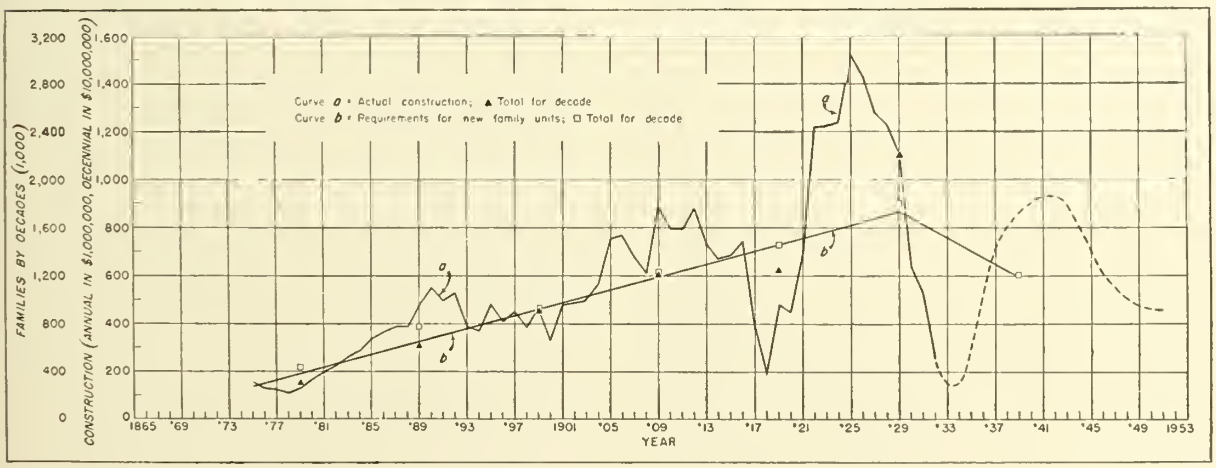

FIGURE 3.—*Construction cycle (in terms of 1913 dollar) and increase in number of families since 1875. Based on data for four cities beginning 1875, varying number of cities to 1900, and 52 cities 1900 to 1932. The dotted line beyond 1932 is based on estimated values.*

TABLE 1.—*Hypothetical pattern for the 1930–49 cycle in residential construction for the whole country*

Year	Dwelling units	Year	Dwelling units
1930	425,000	1940	680,000
1931	180,000	1941	700,000
1932	100,000	1942	700,000
1933	80,000	1943	680,000
1934	100,000	1944	600,000
1935	210,000	1945	520,000
1936	355,000	1946	450,000
1937	500,000	1947	390,000
1938	600,000	1948	350,000
1939	650,000	1949	330,000
Total for decade	3,200,000	Total for decade	5,400,000

It should be emphasized that the figures in table 1 for prospective annual construction represent only a suggested pattern. The curve will not be a smooth one in any case, and the general form may be quite different without changing the total. The National Bureau of Economic Research [1] in an analysis of actual construction gives the number of dwelling units built from 1933 to 1936 as about 25 percent less than the corresponding figures in table 1, but with the pattern remaining much the same. A lag behind the pattern does appear, however, in the permit records for 1937 as published by the Bureau of Labor Statistics, which show only a slight increase (about 5 percent) over 1936. This lag may mean that the suggested pattern is too steep or it may merely constitute a variation that will be made up by construction in 1938 or 1939 higher than the pattern. Should actual construction continue to lag through 1939, it would seem to indicate that the total estimate for the cycle is too high. Similarly, recovery in construction to 1941 exceeding the hypothetical pattern could indicate two possibilities—either that the total estimate is too low, or that the decline from the crest will be greater than the pattern shows.

As already noted, the estimates of prospective residential construction are susceptible to revision whenever changes appear in the factors of population and persons per family. One result of the depression has been to retard farm-to-city migration so that the increase in nonfarm population since 1930 has been below the anticipated normal. A revised estimate on the basis of actual nonfarm population increase would fall in line with actual construction. However, no revision is considered necessary at this time (1938) in the estimated construction volume for the entire period 1930 to 1949. It is believed industrial recovery will see the delayed construction as of 1938 balanced by construction for the remainder of the period going higher than is indicated in table 1.

The depression not only retarded the farm-to-city migration but resulted also in some doubling up, so that persons per living unit did not continue its normal drop after 1929. There is no way of knowing just what this factor is, but its possible effect is illustrated in table 2. Here again, a return to normal should cancel the effect of the depression. Industrial prosperity will bring undoubling and a resumption of the downtrend in persons per living unit.

The annual increases in nonfarm families given in table 2 are computed by dividing the difference between Thompson and Whelpton estimates for total population and estimates of farm population by the Department of Agriculture [2] by persons per family as given in the census data.[3] Census figures

[1] WICKENS, DAVID L., and FOSTER, RAY R. NONFARM RESIDENTIAL CONSTRUCTION, 1920–36. Natl. Bur. Econ. Research Bull. 65, 20 pp., illus. 1937. The figures for these 7 years are 286,000, 212,000, 74,000, 54,000, 55,000, 144,000, 282,000.

[2] UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS. FARM POPULATION ESTIMATES, JANUARY 1, 1937. 14 pp. [Mimeographed.]

[3] Increase in number of families can also be estimated in terms of marriages, plus net families added by immigration, minus families dissolved by death and divorce, minus doubling-up of families. In the case of nonfarm families there would be the additional factor of farm-to-city and city-to-farm migration. This method was used in the report of the National Resources Committee on The Problems of a Changing Population, May 1938. It is also used by Lowell J. Chawner in a chapter on residential construction in terms of related economic and other social influences to be published shortly in a report on housing by the National Resources Committee. Increase in families to 1960 is approximately 10 percent greater by this method than by projection of trend in persons per family. After careful consideration, it was decided to adhere to the original procedure based directly on trend in persons per family. The trend in persons per family is really a summation of all the several factors, marriage, dissolution of family by death and divorce, doubling and undoubling, etc., and avoids the necessity of separate assumptions for each factor individually, particularly when the factors are not all known. Incidentally the family as used in this report, and in the census, is a household, and it is in that sense that it measures need for housing. The family as determined from marriage, divorce, etc., must be corrected to household, and this is difficult without the necessary data on doubling-up, as is well illustrated by the situation since 1930.

on persons per family are by decades, and the change is assumed to be uniform from year to year. Year to year variations from the normal are usually of no consequence but, as indicated in table 2, there is difficulty temporarily because of uncertainty as to trend of persons per family during the depression. The larger figure given for these years is arrived at by assuming that persons per family continued to decline at the rate prior to 1930. The lower estimates are based on the assumption that the depression caused some doubling up, resulting in very slight decrease in persons per family for those years, if indeed there was not an actual increase for a few years. Perhaps the correct figures are between the two extremes given for 1930–36.

Table 2.—*Increases in nonfarm families by years, 1910–36*

Year	Increase	Year	Increase	Year	Increase
	Number		*Number*		*Number*
1910	463, 000	1919	385, 000	1928	446, 000
1911	375, 000	1920	495, 000	1929	453, 000
1912	506, 000	1921	545, 000	1930	221, 000–357, 000
1913	570. 000	1922	658, 000	1931	109, 000–245, 000
1914	457, 000	1923	692, 000	1932	27, 000–171, 000
1915	413. 000	1924	540, 000	1933	200, 000–335, 000
1916	450, 000	1925	566, 000	1934	220, 000–374, 000
1917	422. 000	1926	620, 000	1935	294, 000–385, 000
1918	253, 000	1927	498, 000	1936	350, 000–384, 000

The point is, that volume of construction and increase in nonfarm families after 1930 were both less than had been anticipated and the parallel movement is additional evidence of the close relation between the two. Presumably construction, in spite of low volume, has not been greatly out of line with the primary factor in demand. A decline in rents, beginning in November 1937 and continuing through the summer of 1938, is further confirmation of this assumption.

The situation is shown graphically in figure 4. Excess of new construction over increase in families from 1922 to 1929 not only wiped out the shortage carried over from 1920 but left a surplus as of 1930. With a surplus to be absorbed, the small increase in families since 1930 has not yet developed the normal demand for new dwellings. Perhaps some delayed construction will never be made up, but that is not true for most of the delayed housing. Industrial prosperity would release people on the farms who would normally have moved to the city; it would mean young people who have been delaying marriage would get married; it would permit doubled-up families to move into separate dwellings.

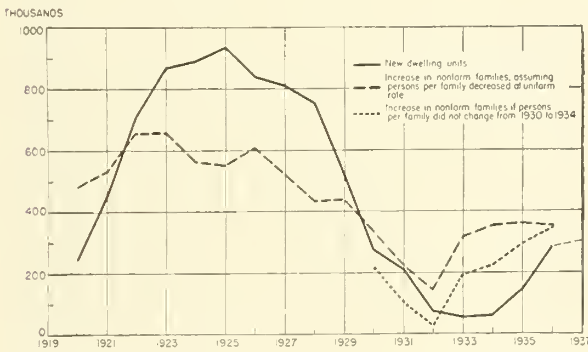

Figure 4.—*Relation of low volume of residential construction since 1930 to low increase in nonfarm families.*

Lumber per Family Living Unit

JUST as the number of living units is the recognized measure of volume of residential construction, so any usable factor for the conversion of residential construction to its equivalent in lumber must be expressed in board feet per living unit.

Derivation of this factor involves the determination of such other independent factors as size of unit and type of construction. There is a general opinion that the average unit is getting smaller. The increasing use of materials other than lumber is apparent. The situation is complicated by the trend to apartments or multifamily housing. That is, the movement from one-, and two-family dwellings to multifamily means changes in both size of unit and materials of construction, wholly apart from any change or lack of change within either of the fields. It has been necessary, therefore, to analyze not only the size of unit and the board feet of lumber per cubic foot of volume for both one- and two-family and multifamily construction, but also the movement from the one to the other.

Size of Living Unit

Three separate field studies were made for size of living unit—one in California, one in Washington and Oregon, and one in selected cities of the East. The California study covered 7 California cities, ranging in population from 35,000 to 1,250,000; the Washington-Oregon study included 14 cities ranging from 4,000 to 365,000. The third study covered Washington, D. C., Waterbury, Conn., Madison, Wis., Lincoln, Nebr., Shreveport, La., and Charlotte, N. C.

Two difficulties were encountered in the use of building permits to ascertain the cubage of dwellings. Permits usually show over-all length and width instead of net basal area, and correction had to be made for the difference. Analysis of sample plans indicated a correction of 5 to 10 percent. The other difficulty was that in a majority of cases permits did not show height in feet, but only the number of stories. It was therefore necessary to supplement height records with data from building plans and observation of actual construction. The heights arrived at were 15.5 feet for one-story and one-and-one-half-story single-family dwellings and 21.5 feet for two-story single-family dwellings; except that the height for one-story single-family dwellings was 11.8 feet in California, where the one-story house represents a large proportion of all housing and the newer residences are chiefly of the Spanish type of architecture with low gable or flat roofs. Seventy-three percent of all houses in Los Angeles, 55 percent in Berkeley, 75 percent in Oakland, and about 90 percent in the smaller California cities are one-story.

TABLE 3.—*Computed average cubage of dwellings in 4 regions*

Region	1- and 2-family dwellings		Multifamily dwellings	
	Samples	Average volume	Samples	Average volume
	Number	*Cubic feet*	*Number*	*Cubic feet*
Northeast and North Central	2,232	16,230	2,177	8,100
South	873	16,200	158	9,300
Pacific Northwest	17,070	16,250	1,621	9,500
California	1,818	14,950	1,312	9,300
Summary:				
California		15,000		
All other and East		16,250		
North (New England to Prairie)				8,100
South, Southwest, and West				9,300

Average volumes for one- and two-family dwellings were computed by applying the average heights to corrected basal areas obtained from dimensions on building permits in the sample cities. For multifamily dwellings, the average volume per unit was obtained by dividing the volume of the structure by the number of family units. This does not represent actual living space per unit, because of halls, elevators, stairways, and

the like, but it does represent average volume of construction per unit. The computed average volumes for four major regions are given in table 3.

There is apparent a close agreement in the above regional figures, with two exceptions. The one- and two-family units in California are smaller than in the other regions, as already explained. That the average unit in multifamily housing is smaller in the Northeast and North Central than in the other regions is to be expected because of the immense structures with one-, two-, and three-room apartments in the large northern and eastern cities. For simplification, the average unit volumes given in the summary of table 3 are used in computing cubic-foot volume of construction from number of living units.

There seems no reason to anticipate any future increase in size of the average unit. Any change is more likely to go the other way. A report of the New York Tenement Housing Commission shows that in apartments erected from 1902 to 1906 the average unit was 4.6 rooms; from 1921 to 1925 it was 3.8 rooms; and from 1930 to 1935 it was 3.1 rooms. There has probably been a similar trend in one- and two-family dwellings. The trend is, of course, apparent, in a change from one- and two-family dwellings to apartments. A study made by the planning board of New Rochelle, N. Y.,[1] shows that as between families in the same class, building floor area averaged 340 square feet per person in apartments and 470 square feet in dwellings.

Proportion of Wood Construction and Apparent Trends

The next step in setting up the volume of lumber for a living unit of average size is to determine the proportion of wood construction represented by that unit—that is, to what degree the typical structure is all wood; or veneer, in which an outer face of brick, stucco, stone, or other material is used over a wood frame; or masonry, in which the outer wall is solid masonry; or fireproof, in which the structure is entirely masonry or concrete or steel; or a combination of these.

Some difficulty was experienced in this determination. Records kept by the cities do not in many instances show construction materials and even where such records are available, veneer may be classified as frame along with all wood, or simply as brick, stucco, or stone, making no distinction between veneer and solid masonry wall. There is even greater difficulty in determining what the trends are except that there is a discernible trend to other materials in place of wood exterior face on one- and two-family dwellings, and to masonry or fireproof construction for multifamily dwellings.

Reports of 1929 construction obtained from some 90 cities of 25,000 population and over were grouped by regions, and an adjustment made for the construction in communities under 25,000 population. This adjustment was important only in the Middle Atlantic region, where reports for the 5 largest cities present 80 percent of one- and two-family dwellings as masonry. These 5 cities made up 70 percent of the classified reports but contributed less than 25 percent of one- and two-family residential construction in the region. Classified reports for 15 other cities gave only 16 percent of one- and two-family dwellings as masonry wall.

The estimates arrived at for the various regions as of 1929 are given in table 4.

Any future direct displacement of lumber by other materials in multifamily construction must come largely by a change from masonry to fireproof construction. Frame (including all wood and veneer) constituted only about 19 percent of new multifamily construction as of 1929, and hence further change from frame to masonry will be a small factor for the country as a whole. Such a change would be felt only in the Pacific Northwest, in California, and in Florida, where a large percentage of multifamily construction is still frame. A greater decline in use of lumber may, however, take place if there is a subsequent shift to fireproof construction. Masonry still makes up about half of multifamily construction and the drop in board feet per cubic foot is greater from masonry to fireproof than from wood to veneer, or from veneer to masonry.

That the trend away from lumber has not been as large in one- and two-family structures as is generally assumed is shown by a comparison of new construction (represented by reports for 1929 from 70 cities classifying construction by materials used) with the classification for all existing structures by the Real Property Inventory. Comparisons were

[1] Reviewed in Apartment houses or dwellings—which? Housing 19: 179–181 1930.

TABLE 4.—*Distribution of 1929 construction based on reports from 90 cities, by region and type of construction*

1- AND 2-FAMILY DWELLINGS [1]

Region	All wood	Veneer	Masonry	Fireproof
	Percent	*Percent*	*Percent*	*Percent*
New England	90	5	5	0
Middle Atlantic	60	10	30	0
South Atlantic and Southeast	75	20	5	0
Florida	40	55	5	0
Lakes	60	35	5	0
North Central	65	30	5	0
South Central	65	30	5	0
Prairie	75	20	5	0
Southwest	70	20	10	0
North Rocky Mountain and North Pacific	70	30	0	0
South Pacific	10	90	0	0
South Rocky Mountain	10	20	70	0
United States (weighted)	60	28	12	0

MULTIFAMILY DWELLINGS

Region	All wood	Veneer	Masonry	Fireproof
New England	10	0	60	30
Middle Atlantic	0	10	30	60
South Atlantic and Southeast	0	20	70	10
Florida	0	40	40	20
Lakes	0	20	60	20
North Central	0	20	60	20
South Central	0	20	60	20
Prairie	0	20	60	20
Southwest	0	20	60	20
North Rocky Mountain and North Pacific	10	30	50	10
South Pacific	0	70	20	10
South Rocky Mountain	0	10	70	20
United States (weighted)	19		45	36

[1] 1- and 2-family dwellings provided 75 percent of all new units.

made both on the basis of individual cities, where a classified report was available for cities included in the Real Property Inventory (table 5), and on the basis of averages obtained from classified reports and from the Real Property Inventory. Since the inventory did not distinguish between veneer and masonry, but reported brick veneer over frame as brick, a full comparison cannot be made. Reports for Asheville, N. C., Richmond, Va., Dallas, Tex., Portland, Maine, and Portland, Oreg., show percent of "wood" about the same for new construction as for existing dwellings; i. e., very little if any trend away from lumber in the five cities in four different regions. Seattle, Wash., a center of lumber production, shows a strong trend to veneer in contrast with Portland, Oreg. It is quite apparent that the trend away from all wood is almost wholly to veneer with the exception of Wilmington, Del., and Salt Lake City, Utah, where masonry has always predominated. The implication is that in the typical "masonry" regions a change from "wood" is likely to be to masonry, while elsewhere it is to veneer over frame.

TABLE 5.—*Trends in materials used in construction of 1- and 2-family dwellings, as shown by comparison of old and new construction in 16 cities of record*

Cities	New construction [1]			Old construction—wood [2]
	Wood	Veneer	Masonry	
	Percent	*Percent*	*Percent*	*Percent*
St. Joseph, Mo	64	30	6	81
Peoria, Ill	67	33	0	89
Knoxville, Tenn	78	20	2	91
Minneapolis, Minn	9	90	1	60
Wilmington, Del	0	0	100	42
Jacksonville, Fla	66	33	1	89
Asheville, N. C	85	15	0	82
Richmond, Va	53	0	47	59
Birmingham, Ala	65	35	0	87
Atlanta, Ga	39	61	0	82
Portland, Maine	99	0	1	91
Salt Lake City, Utah	16	0	84	31
Pueblo, Colo	20	45	35	52
Dallas, Tex	84	9	7	82
Portland, Oreg.[3]	78	22		84
Seattle, Wash.[3]	22	78		75

[1] Represented by 1929 data from questionnaires.
[2] From Real Property Inventory.
[3] Data for Portland and Seattle are from a special field survey.

Analysis of data for the 64 cities covered by the Real Property Inventory for 1934 classifies existing one- and two-family dwellings approximately as follows:

	Percent
Wood	85
Brick, stone, concrete	7
Stucco	8

It is perhaps safe to assume that the stucco is veneer on frame. Some of the brick is also veneer on frame, but no segregation can be made.

These figures can be compared with one- and two-family construction as of 1929 in table 4 if an adjustment is made for the influence of New York City, Philadelphia, Baltimore, Pittsburgh, and Washington, which are included in table 4 but are not represented in the Real Property Inventory. With these cities omitted, masonry in the Middle Atlantic region drops from 30 percent to 16 percent and masonry for the entire United States drops from 12 percent to 8 percent of all one- and two-

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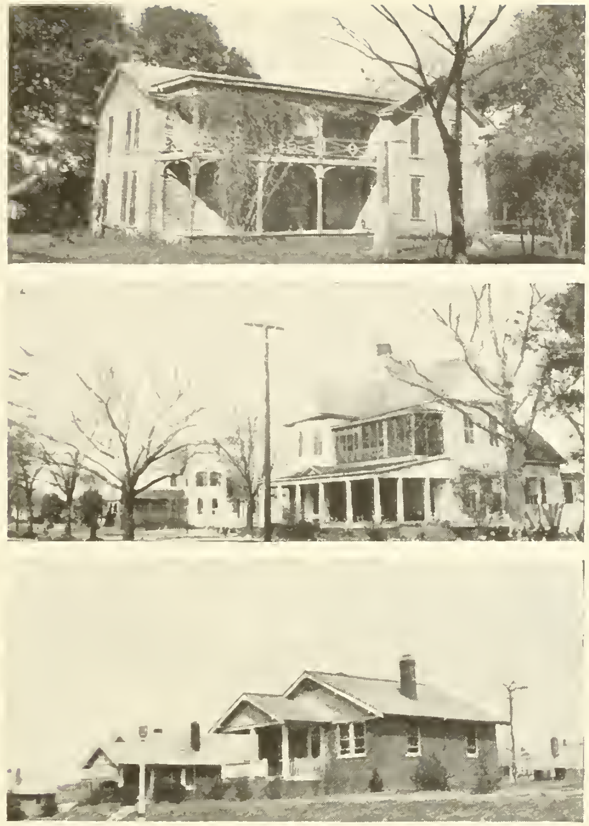
FIGURE 5.—*New England has the highest percent of all-wood houses, and the highest average age compared with the rest of the United States. Better paint conditions are indicative of better maintenance. Top—250-year-old dwelling with massive chimney. Middle—167-year-old farmhouse. Bottom—Typical frame dwelling built in 1788.*



F299314—287424—290538

FIGURE 7.—*Between the colonial period and the new industrial age, houses in the Southeast were typically of wood whereas brick veneer is not uncommon in new construction. Top—A Texas dwelling of 50 years ago. Middle—A Georgia residence of about the same age. Bottom—A typical mill-town dwelling of brick veneer.*

F290543—290542

FIGURE 6.—*From New York to Virginia, brick and all wood are both typical of old and new residential construction. The two examples shown are from Williamsburg, Va.*

F287431—287403

FIGURE 8.—*The Spanish influence (top) has always been noticeable in Florida and accounts for the high proportion of stucco in new construction (bottom).*

family units. This indicates no appreciable change in proportion of masonry in one- and two-family structures.

Even if stucco is assumed to be veneer on frame and part of the brick also veneer on frame, veneer cannot be raised much above 10 percent. The change in construction of one- and two-family dwellings can therefore be represented by new construction 92 percent frame, of which 60 percent is all wood and 32 percent is veneer, as against existing or older construction 95 percent frame, of which 85 percent is all wood and 10 percent veneer.

The photographs shown in figures 5 to 10 were selected from many that were taken as part of the field work on this study. While it would be difficult to decide on a particular house as being typical for any region, or to prove that it was typical, differences between regions are nevertheless easily recognized, and an effort was made to select pictures which would be representative of such differences.

The all-wood houses, colonial, painted white (fig. 5), are readily recognized as New England. Such houses can be found in almost every locality, particularly throughout the North, but in New England they are everywhere. As the observer moves south from New England he finds in the Middle Atlantic region a conspicuous use of masonry along with wood (fig. 6). The design is still colonial and painting is kept up.

In the Southeast and South (fig. 7) masonry is less evident in the older houses but the use of brick veneer over frame is quite noticeable in new construction. A change in size from the old to the new is also apparent.

Stucco on frame, like the colonial house, is well represented in all parts of the country, but is most typical of Florida (fig. 8) and California, where its use indicates the persistence of tradition, just as does the white frame house in New England and the brick house in the Middle Atlantic region.

California is credited with giving us the bungalow. It is well represented in all parts of the country, but it seems particularly at home in the Plains States (fig. 9).

Fashions in houses change and there has been a succession of styles in new construction as in new clothes. A recent one is represented in the top picture in figure 9 and in figure 10. The fashion influence is more or less general everywhere, in contrast with the traditional influence which differs with localities.

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Figure 9.—*Small houses in the southern Plains States. The California bungalow has been generally adopted in these States.*

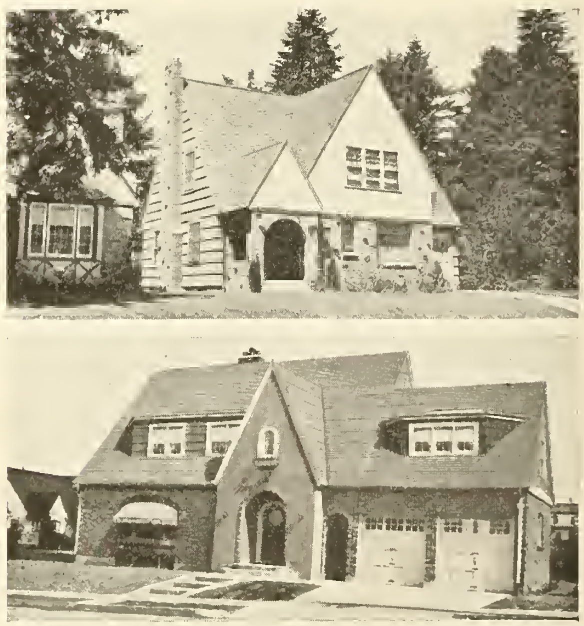

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Figure 10.—*These two houses in the Pacific Northwest show a style influence that has been quite evident in most sections of the United States since 1920, excepting possibly in New England, Florida, and California.*

One- and Two-Family versus Multifamily Dwellings

It is readily apparent that the movement from one- and two-family dwellings to multifamily housing is in itself a factor in the volume of lumber per living unit. The average volume of the multifamily dwelling, as shown in table 3, is 8,100 cubic feet, in contrast with the 16,250 cubic-foot volume of the one- and two-family house. The exchange of one living unit in one- and two-family construction to multifamily is therefore equivalent to a cut of one-half in cubic volume, regardless of any further effect on lumber requirements accounted for by differences in the respective conversion factors.

The trend in one- and two-family versus multifamily construction since 1921 in cities of 25,000 population is shown in table 6 and in figure 11, based on the records for the 257 cities compiled by the Bureau of Labor Statistics. The apartment has already absorbed the three- and four-family structure under the designation of multifamily, but it is apparent from these figures that even the two-family structure is declining in favor of multifamily housing. Multifamily units declined from a high point of 54 percent in 1928 to 16 percent in 1932, but immediately recovered, reaching 43 percent in 1936. For the period 1921 to 1936, multifamily averaged about 40 percent of all new family units and presumably this percent will be maintained or possibly increased. Single family dwellings returned in the same period nearly to the 1921 level; but two-family housing shows no corresponding recovery.

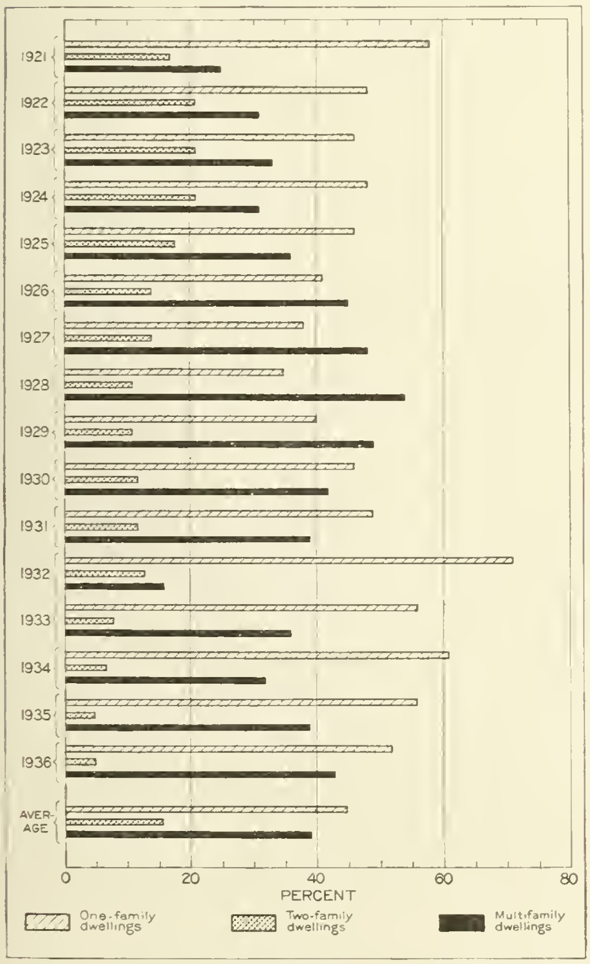

FIGURE 11.—*Percent distribution of new dwellings between one-family, two-family, and multifamily, 1921–36.*

In the smaller cities and rural communities, accounting for 55 percent of all residential construction from 1921 to 1930, the multifamily structures are a much smaller percent of total residential construction. Records of the Bureau of Labor Statistics since 1932, including cities of 10,000 population, show that in cities of 10,000 and less than 25,000 population, multifamily structures provided in 1935 approximately 5 percent of all new family units. For communities below 10,000 population the percent of multifamily units should be even less. With these smaller towns included, the percent of multifamily in all urban housing would

TABLE 6.—*Number of families provided for in different kinds of dwellings built annually in 257 identical cities, 1921–36*

Year	1-family dwellings	2-family dwellings [1]	Multifamily dwellings [2]	All classes of dwellings
	Number	*Number*	*Number*	*Number*
1921	130, 873	38, 858	54, 814	224, 545
1922	179, 364	80, 252	117, 689	377, 305
1923	207, 632	96, 344	149, 697	453, 673
1924	210, 818	95, 019	137, 082	442, 919
1925	226, 159	86, 145	178, 918	491, 222
1926	188, 074	64, 298	209, 842	462, 214
1927	155, 512	54, 320	196, 263	406, 095
1928	136, 907	43, 098	208, 673	388, 678
1929	98, 164	27, 813	118, 417	244, 394
1930	57, 318	15, 145	52, 859	125, 322
1931	48, 330	11, 310	38, 538	98, 178
1932	19, 528	3, 400	4, 453	27, 381
1933	14, 437	2, 124	9, 318	25, 879
1934	13, 397	1, 457	7, 209	22, 063
1935	31, 030	3, 023	21, 757	55, 810
1936	59, 855	5, 328	50, 182	115, 365
Average	111, 087	39, 246	97, 232	247, 565

[1] Includes 1-family and 2-family dwellings with stores.
[2] Includes multifamily dwellings with stores.

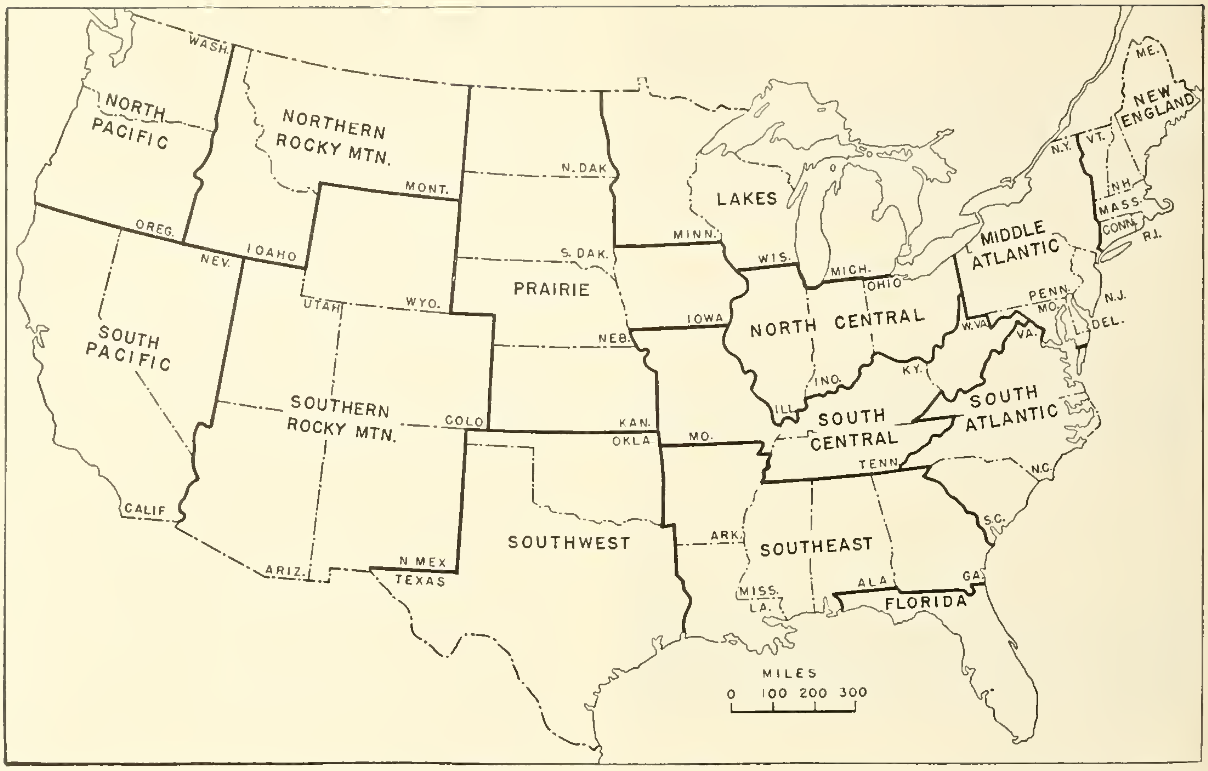

FIGURE 12.—*Regions used in presenting lumber requirements. These are slightly at variance with those usually employed in statistical estimates of forest resources in that the Central region is here divided into North and South Central, and East Gulf and lower Mississippi are divided into Southeast, Florida, and Southwest.*

be only slightly more than half the percent for cities of 25,000 and over, or about 25 percent of new family units.

In no case, however, can these average figures be applied to individual cities. Cities in the same region and even in the same size group vary so widely in percent of multifamily housing as to make any such calculation meaningless. This is well illustrated by the 7-year record for Baltimore, Washington, Detroit, and St. Louis shown in table 7.

Because of this wide variance, and inasmuch as estimates of lumber requirements are to be correlated with forest resources by established forest regions, it is necessary to consider the prevalence of multifamily housing by regions. The estimates presented in table 8 (by the regional grouping of States shown in figure 12) were reached by tabulating the 1929 construction records for cities of more than 25,000 population as published by the Bureau of Labor Statistics. These totals were adjusted for construction in smaller communities by the method used for the country as a whole. The weighted average so obtained for all regions checks against the 25 percent of multifamily housing for the entire country.

TABLE 7.—*A comparison of new living units in multifamily dwellings in 4 different cities, 1930–36*

Year	Baltimore	Washington	Detroit	St. Louis
	Percent	*Percent*	*Percent*	*Percent*
1930	3.0	49.8	14.1	36.6
1931	15.9	61.1	6.2	22.5
1932	17.3	21.6	0	5.1
1933	0	11.4	1.1	0
1934	0	22.3	0	42.1
1935	.8	55.6	1.5	1.9
1936	.7	68.1	2.3	6.2

The high percent for the Middle Atlantic region is due largely to the influence of New York City, which accounts for approximately one-third of all multifamily construction. New residential construction in the city of New York is about 75 percent multifamily and in the Borough of Manhattan 100 percent.

It may be assumed for these regional percents, as for those of the larger cities in the country as a

TABLE 8.—*Percent of new construction in multifamily housing, by regions, 1929*

Region	Population		Multifamily housing	
	Cities of 25,000 and over	All non-farm	Cities of 25,000 and over	All non-farm
			Percent	*Percent*
New England	4,400,000	7,700,000	30	25
Middle Atlantic	16,800,000	26,700,000	65	40
North Central	8,000,000	14,700,000	45	25
Lakes	4,400,000	7,800,000	26	20
Prairie	1,250,000	4,100,000	22	10
South Central	2,800,000	6,650,000	42	20
South Atlantic	1,100,000	3,900,000	15	10
Florida	470,000	1,200,000	12	10
Southeast	2,200,000	5,500,000	15	10
Southwest	1,900,000	4,900,000	18	10
Southern Rocky Mountain	630,000	2,000,000	32	15
Northern Rocky Mountain	70,000	600,000	15	10
North Pacific	930,000	2,000,000	41	20
South Pacific	3,200,000	5,000,000	50	25
Total	48,150,000	92,750,000	45	25

whole, that they represent a fair, and if anything a conservative, estimate of future multifamily construction.

Lumber per Cubic-Foot of Construction Volume

Originally it was expected that conversion factors of board feet of lumber per cubic foot of dwelling would have to be determined separately for detached dwellings and multifamily structures. This proved unnecessary, however, inasmuch as no appreciable difference was found in the board foot-cubic foot relation between detached and multifamily construction of the same materials. Fireproof construction in the residential field is confined pretty much to the large apartment buildings in metropolitan centers. Masonry walls for single-family dwellings is typical in the Middle Atlantic and Central and Southern Rocky Mountain regions, as is indicated not only by the large proportion of masonry but by its use in all price classes. In the Middle Atlantic it is a carry-over from colonial days, whereas farther west it bears a direct relation to the fact that timber was never plentiful. In other regions masonry enters only in the higher-price classes and is a small proportion of the total number of units.

Lumber lists were obtained from contractors, architects, and lumber dealers for 82 detached dwellings in 10 selected cities—Lincoln, Nebr., Madison, Wis., Schenectady, N. Y., Springfield, Mass., Waterbury, Conn., Washington, D. C., Charlotte, N. C., Montgomery and Mobile, Ala., and Shreveport, La. Similarly, data were obtained for 27 dwellings in 7 California cities, and 27 dwellings in Portland, Oreg. The three groups were analyzed independently by different people with the results given in table 9.

TABLE 9.—*Lumber used in dwellings of frame construction, in board feet per 1,000 cubic feet volume*

Lumber use	General (82 samples)	California (27 samples)	Portland, Oreg. (27 samples)	Derived conversion factor
Framing	425	535	466	440
Sheathing	315	360	343	325
Flooring	110	110	64	110
Finish (trim and millwork)	150	75	162	150
Veneer construction (excludes outer face)	1,000	1,080	1,035	1,025
Siding	124	120	138	125
All-wood house	1,124	1,200	1,173	1,150

The three groups agree closely as to total and show marked disagreement in only two instances when broken down to the five major items. It is possible to explain the larger footage of framing and sheathing per 1,000 cubic feet for California by the low-roof factor already mentioned. That is, flatter roofs reduce the cubic volume for the same living space and for the same amount of lumber. The smaller volume of finish for California may be due to greater use of plaster-reveal construction for doors and windows and narrower trims where wood trim is used. There is also a reason for the low flooring figure for Portland; it seems to be common practice in the Pacific Northwest to use $\frac{5}{16}$-inch hardwood flooring, which reduces the board footage for this item by one-third. But there is a $\frac{1}{2}$-inch softwood subfloor between the hardwood flooring and the floor sheathing which adds to the sheathing. The only difference between the veneer and all wood is in the outer face.

In arriving at the final conversion factor the California figures for framing and sheathing were discarded because of the difference in volume mentioned above.[2] The California figure for trim and

[2] It is not at all unlikely that part of the divergence of California from the average could be explained by difference in classification of rough and finish. When rough and finish are combined the divergence can be accounted for on the basis of volume alone.

the Portland figure for flooring were also discarded, since they introduce local factors that cannot be included in an average for the whole country. When the remaining items were averaged to conservatively rounded values, the factors obtained were 1,150 board feet for frame and 1,025 feet for veneer.

California presents an exception to the generalization that masonry and fireproof construction predominate in large apartment buildings. Over 70 percent of new multifamily housing built in California from 1929 to 1931 was frame construction. From five samples, the conversion factors in this construction were found to be:

Construction lumber	710
Finish and flooring	172
Sash and door	29
Total	911

The finish and sash and door items are approximately 10 percent greater than in one-family dwellings, but construction lumber is 25 percent less than the same item for one-family dwellings in California, and 5 or 10 percent less than in one-family dwellings outside California. There are no data to indicate a similar difference in other regions, nor is frame construction a factor in large apartment buildings in other regions.

The converting factor for masonry was arrived at by deducting outer wall framing and sheathing from frame construction. As a check against that method, bills of material were also obtained on 65 masonry dwellings, 53 of which were row houses, representative of construction in many of the older cities in the Middle Atlantic region, and 12 detached dwellings of which 10 were in Washington, D. C., and 2 in Lincoln, Nebr. Although the 10 Washington dwellings ranged in size from 17,000 to 175,000 cubic feet, this had no effect upon the board foot-cubic foot relation. Nor was there any appreciable difference between the row houses and the detached houses. The board-foot ratio for the two Lincoln samples was 10 percent less than the average for the Washington dwellings, but formed an insufficient basis for setting up any regional difference. The conversion factor in board feet per thousand cubic feet computed from these samples for masonry construction in one- and two-family dwellings was derived as follows:

Construction lumber	580
Flooring	110
Other finish	140
Total	830

Fireproof construction of dwellings is negligible except in the multifamily class and even in that class it is confined to the large apartment buildings in metropolitan centers. These apartment buildings differ very little from office and similar commercial buildings in the structural use of lumber. That is, form lumber, scaffolding, and similar temporary uses are the same and practically make up the entire construction-lumber item. Data on construction lumber were obtained mainly from samples covering hotels, office buildings, and other fireproof construction. The difference between the commercial and residential construction is in interior or finish lumber, on which data were available on four samples. Wood flooring is the common practice in apartments except for entrance and halls. Interior trim and millwork are used much as in other residential construction. Practice varies as between wood and metal windows. The following conversion factor (board feet per 1,000 cubic feet) for multifamily dwellings of fireproof construction is based on four sample apartments in Washington, D. C., supplemented by data on construction lumber from other buildings of fireproof construction:

Construction lumber	205
Flooring	80
Other finish	65
Total	350

The final factors employed in converting cubic-foot volume to board feet of lumber consumed under present conditions in the different types of residential construction are brought together in table 10.

TABLE 10.—*Current conversion factors—board feet of lumber per thousand cubic feet of volume—in residential construction*

Type of dwelling	1- and 2-family	Multi-family
All wood	1,150	
Veneer over frame	1,025	1,025
Masonry wall	830	830
Fireproof		350

The question arises naturally as to what change in the average volume of lumber per living unit in recent years is indicated by these figures. Thirty years ago multifamily construction (three families and more per structure) was 10 percent of total new units compared with the current 25 percent; one- and two-family construction was 85 percent all

wood, 10 percent veneer, and 5 percent masonry; and multifamily was 60 percent masonry and 40 percent frame. Also, three- and four-family wood structures were a much larger proportion of multifamily construction 30 years ago.

The change in board-foot average per living unit for all residential construction might be illustrated as follows:

	Board feet
Earlier construction (30 years ago):	
90 percent one- and two-family at 18,216	16, 400
10 percent multifamily at 10,000	1, 000
Per unit	17, 400
Current construction:	
From table 15, 7,120,000 units and 100,812,000 thousand board feet—per unit	14, 200
Decrease in lumber per unit	3, 200

The difference is of course larger in some regions and smaller in others. For example, current construction in the Southeast is estimated from table 15 as 17,000 board feet (349,000 units and 5,904,000 thousand board feet). Earlier construction in the Southeast might reasonably be estimated as all one- and two-family, with lumber for the average unit based on 95 percent all wood and 5 percent masonry:

	Board feet
95 percent of 16,200 at 1,150	17, 700
5 percent of 16,200 at 830	700
	18, 400
Decrease per unit	1, 400

So far as could be told from data available, the conversion factor for the all-wood house has not changed. The explanation seems to be that whereas more wood was used in trim and perhaps in partitions in the older construction, double floors and sheathing under the weather boarding are more general in new construction than in old.

Additions, Alterations, and Repairs

ADDITIONS, alterations, and repairs are of less importance than new construction but have nevertheless averaged about 15 percent of total building construction over a period of years. They are, furthermore, more stable than new construction and hence form a larger part of total construction during slack periods than during boom periods. This is very clearly indicated in figure 13, illustrating the relative expenditures for additions, alterations, and repairs for the 257 cities as compiled by the Bureau of Labor Statistics and those for total building operations in these cities as shown by index numbers on a 1921 base. The actual expenditures are given in table 11.

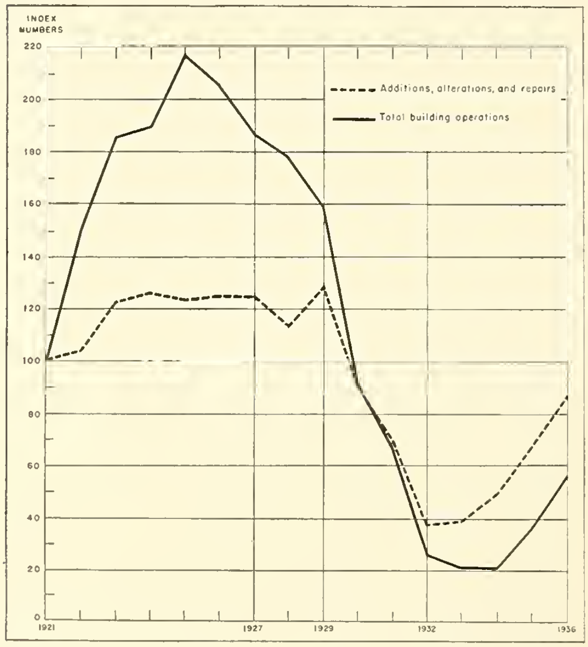

FIGURE 13.—*Comparative cost trends of additions, alterations, and repairs and of total building operations from 1921 to 1936 as shown by index numbers.*

If the average age for existing buildings increases, there should be an increase in the repair item. At the same time, the prospect of a smaller volume of new construction than that from 1920 to 1929 tends to increase the relative importance of repair. In such estimates of probable repair and alterations there is, however, no mensurable factor to rely on comparable to increase in families in estimating new construction. Nor is there a means for converting expenditures for repairs to feet of lumber comparable to that for converting cubic feet of housing. According to an analysis of 1929 permit data, residential repairs are 40 percent of total building repairs, or approximately $140,000,000 for the 257 reporting cities for that year. Approximately the same relation between residential and total repairs was evident in a classification by major types of repair permits for Washington, D. C., for 1929. Total valuation for these items is as follows:

TABLE 11.—*Estimated expenditures for additions, alterations, and repairs, and for total building operations, 1921–36*

Year	Additions, alterations, and repairs	Total building operations
1921	$272, 805, 727	$1, 837, 841, 665
1922	283, 378, 341	2, 767, 782, 634
1923	334, 866, 768	3, 398, 884, 406
1924	344, 548, 496	3, 508, 266, 587
1925	337, 181, 971	4, 038, 066, 479
1926	341, 314, 531	3, 826, 927, 204
1927	340, 815, 133	3, 478, 604, 263
1928	309, 705, 975	3, 304, 699, 712
1929	351, 699, 718	2, 933, 212, 041
1930	247, 068, 224	1, 697, 724, 944
1931	188, 357, 233	1, 237, 457, 788
1932	102, 249, 230	481, 490, 267
1933	108, 165, 213	382, 529, 358
1934	136, 242, 077	379, 227, 689
1935	183, 196, 018	655, 302, 190
1936	237, 784, 709	1, 042, 048, 114

Residential:

Additions, alterations, and repairs to porches (640 permits)	$142, 535
General additions, alterations, and repairs using lumber (550 permits)	784, 763
General additions and alterations without lumber (315 permits)	102, 300
Total residential permits (1,505)	1, 029, 598

Commercial:

Show window (145 permits)	$94, 130
Additions and alterations using lumber (185 permits)	1, 244, 250
Additions and alterations using no lumber (115 permits)	271, 115
Total commercial permits (445)	1, 609, 495
All permits (1,950)	2, 639, 093

It would seem reasonable to assume that additions, alterations, and repairs would use proportionately the same amount of lumber per dollar as in the construction of the dwelling, even where the board footage per dollar is lower, as in Washington, D. C. The average for new construction for the whole country is about 5 board feet of lumber per dollar cost. This might be high for the Middle Atlantic region and low for the South and West. Several samples were taken to check the correspondence to this figure of lumber footage per dollar of repair.

In a typical month's work of one contractor in Washington, D. C., doing only repair and alteration ($4,620 volume), the lumber items were lumber $625, millwork $404, and flooring $144. As nearly as could be determined, this must approximate 5 board feet per dollar cost, but would not be applicable to heating, plumbing, and lighting jobs.

A particular remodeling job costing $1,600 included $300 for lumber and $115 for hardwood flooring. Carpentry labor was $210. This job would amount to approximately 6 board feet per dollar cost.

Another contractor in Washington, D. C., states that if heating and electric jobs which do not use lumber are excluded, lumber and millwork make up about 50 percent of the total cost, lumber being one-third and millwork two-thirds of the 50 percent. This would put board footage at 5 or less per dollar.

A renovation job reported in Minneapolis costing $2,267 included $248 for sash, doors, and frames and $94 for lumber, or considerably less than 5 board feet per dollar.

A sample survey made in Portland, Oreg., showed a consumption of 1,588,313 board feet with a total expenditure of $376,439, or slightly more than 4 board feet per dollar. One-fourth of the total expenditure was for jobs which used no lumber, so that on jobs using lumber the average is 5.5 board feet per dollar.

Table 12 summarizes a similar survey in California showing an average of 5.7 board feet per dollar of actual cost. In this survey the actual cost was found to average about 13 percent higher than the permit cost, indicating that board footage based on permit figures should be increased by at least 12 percent. This would raise the factor for California to more than 6 board feet as compared

TABLE 12.—*Board feet per dollar cost of additions and repairs in four California cities*

Nature of repair and city [1]	Average cost of repairs		Lumber used	Board feet—dollar ratio [2]
	Actual	Permit		
Residential alterations:	*Dollars*	*Dollars*	*Board feet*	
Oakland (46)	12, 223	10, 816	60, 660	5. 0
Berkeley (12)	6, 340	6, 100	18, 630	2. 9
Fresno (9)	3, 215	2, 590	24, 080	7. 5
Los Angeles (21)	8, 050	6, 765	36, 585	4. 5
Average (88)	9, 504	8, 365	45, 442	4. 7
Fire repair:				
Oakland (10)	4, 570	4, 040	22, 786	5. 0
Los Angeles (8)	8, 190	6, 790	44, 530	5. 4
Average (18)	6, 179	5, 262	32, 450	5. 3
Residential additions:				
Oakland (24)	6, 350	5, 795	56, 640	8. 9
Berkeley (11)	6, 665	4, 765	43, 230	6. 5
Fresno (2)	900	900	11, 000	12. 2
Los Angeles (29)	17, 285	16, 475	100, 735	5. 8
Average (66)	11, 042	10, 168	72, 397	6. 8
Average (172)	9. 746	8, 732	54, 426	5. 7

[1] Number of questionnaires received shown in parentheses.
[2] Figured on actual cost.

TABLE 13.—*Estimated total annual lumber requirements for urban residential repair and alteration in the United States, by regions*

Region	Estimate of nonfarm families by 1950	Lumber per unit	Total lumber required
	Number	*Board feet*	*Thousand board feet*
New England	2, 300, 000	60	138, 000
Middle Atlantic	8, 400, 000	40	336, 000
Lakes	2, 600, 000	50	130, 000
North Central	4, 700, 000	50	235, 000
South Central	2, 200, 000	50	110, 000
Prairie	1, 200, 000	50	60, 000
South Atlantic	1, 400, 000	50	70, 000
Florida	440, 000	50	22, 000
Southeast	1, 800, 000	50	90, 000
Southwest	1, 600, 000	50	80, 000
South Rocky Mountain	600, 000	40	24, 000
North Rocky Mountain	170, 000	50	8, 000
North Pacific	630, 000	60	38, 000
South Pacific	2, 000, 000	50	100, 000
All regions	30, 040, 000	48	1, 441, 000

with 4 board feet for Washington and Oregon, and 4 to 5 board feet for other samples.

Permits reported by the previously cited 257 cities for additions, alterations, and repairs totaled approximately $300,000,000 annually from 1921 to 1930. Raising this amount by 12 percent to approximate actual cost, and assuming 40 percent of this total to be for residential and 5 board feet per dollar to represent the lumber used, produces a total of 672 million board feet consumed annually in the 257 cities. On that basis, the estimate for total urban residential repair would be something like 1.4 billion board feet. This figure may be a little high as judged by the 1921–30 decade, owing to a slight exaggeration in the 5-board-feet-per-dollar factor for those years; but number of dwellings is continually increasing and this alone involves a natural increase in total alteration and repair, possibly making 1.4 billion feet somewhat too low for future decades. In either case, the difference is not likely to constitute a serious error in this estimate.

A regional distribution of this total is shown in table 13. Regional estimates are naturally less reliable than the total figure, but it is felt that those supplied in the table are in no case seriously in error. With a probable 30 million families, the average lumber consumption per family for residential repair and alterations is 48 board feet. Variations from this average to allow for regional differences in construction are used in estimating the regional totals.

Estimated Lumber Requirements

LUMBER requirements for urban residential construction were computed in accordance with the foregoing analysis for regions and for States within regions. Table 14 shows the derivation of the regional factors of board feet per dwelling unit employed in these computations.

Because of the very considerable differences in proportion of housing in multifamily dwellings in the large eastern cities, it was necessary in the New England and Middle Atlantic regions to derive separate factors for the individual States. Elsewhere the regional factor was generally applicable. Table 15 gives the total computed volumes of lumber for both new and supplementary construction for the past, present, and approaching decades. The State figures will attract greater interest than the regional, but it should be realized that the forecasts for a State or other subdivision are inevitably and invariably less reliable than estimates for the country as a whole. Industrial change or the discovery of some new resource may materially affect internal population movements when there is no change in the trend of total population.

The large decline in lumber required for residential construction during the 1930–39 decade as compared with the previous decade by no means indicates that lumber is passing out as a housing material. The drop was in line with the decline in volume of construction. Lumber per living unit is holding fairly well and, if future volume of construction coincides with estimates, lumber requirements for residential construction should hold their own at around 6.4 billion board feet annually, making a total requirement with the repair item added of 7.8 billion feet.

It is quite common to show trends in lumber consumption on a per capita basis, but the analysis of residential construction shows clearly a fallacy in per capita figures not generally recognized. The estimated prospective lumber requirement for new residential construction from 1930 to 1949 (table 15) averages about 64 board feet per capita of urban population. The average for the decade 1920 to 1929 was about 115 board feet. Change in the per capita consumption is negligible, however, when figured on the basis of the same cubic volume of dwelling per person, the same lumber volume per cubic foot of dwelling, and the same life of dwelling. In other words, the high per capita figure of the last decade is explained by the large volume of construction to house new families, with the lumber charged off as consumed as soon as built into dwellings although the dwellings are to last for 50 or 100 years.

The fallacy can be illustrated in another way. A family living in California during the decade 1920–29 would be credited with a per capita consumption of 280 board feet of lumber for new housing. Put the same family and its dwelling in the Prairie States and it would be credited with a consumption of only 80 board feet per capita for new housing, although the lumber used to house this family is about the same in both cases.

Assuming that population will be near stabilization about 1950, volume of new residential construction will be largely for replacement after that time. Migration will still result in some localities gaining and others losing, but part of this will be equivalent to replacing an old dwelling in one locality with a new one in another. Also, the internal migration is not likely to be relatively so large after 1950 as it has been heretofore, because population growth, which in the past greatly encouraged migration, will presumably have abated.

There have always been improvements in transportation, changes in style or type of construction, and new equipment, and in the future these factors are less likely than in the past to shorten the useful life of dwellings. Also, the urge to reduce upkeep and carrying charges, the extension of zoning regulations to prevent obsolescence, and increased competition for the family dollar, all work toward longer life of dwellings. The frequent estimates of

TABLE 14.—*Derivation of regional and State [1] factors for conversion of dwelling units to board-foot volume of lumber consumed*

Region and type of construction	1- and 2-family units				Multifamily units				Region or State factor, all units
	Type distribution	Dwelling volume distribution	Conversion factor	Lumber per average unit	Type distribution	Dwelling volume distribution	Conversion factor	Lumber per average unit	
New England:	*Percent*	*Cubic feet*	*Board feet*	*Board feet*	*Percent*	*Cubic feet*	*Board feet*	*Board feet*	*Board feet*
Frame	90	14,625	1.15	16,819	10	810	1.15	932	
Veneer	5	813	1.02	829					
Masonry	5	812	.83	674	60	4,860	.83	4,034	
Fireproof					30	2,430	.35	850	
All types	100	16,250		18,322	100	8,100		5,816	
Weighted average volume for region	75			13,742	25			1,454	15,196
Massachusetts	65			11,909	35			2,036	13,945
Connecticut	75			13,742	25			1,454	15,196
All other	90			16,490	10			582	17,072
Middle Atlantic:									
Frame	60	9,750	1.15	11,212					
Veneer	10	1,625	1.02	1,658	10	810	1.02	826	
Masonry	30	4,875	.83	4,046	30	2,430	.83	2,017	
Fireproof					60	4,860	.35	1,701	
All types	100	16,250		16,916	100	8,100		4,544	
Weighted average volume for region	58			9,811	42			1,908	11,719
New York	40			6,766	60			2,726	9,492
Pennsylvania and Delaware	80			13,533	20			909	14,442
New Jersey	70			11,841	30			1,363	13,204
Maryland	90			15,224	10			454	15,678
District of Columbia	50			8,458	50			2,272	10,730
South Atlantic and Southeast:									
Frame	75	12,188	1.15	14,016					
Veneer	20	3,250	1.02	3,315	20	1,860	1.02	1,897	
Masonry	5	812	.83	674	70	6,510	.83	5,403	
Fireproof					10	930	.35	326	
All types	100	16,250		18,005	100	9,300		7,627	
Weighted average volume for region	90			16,204	10			763	16,967
Florida:									
Frame	40	6,500	1.15	7,475					
Veneer	55	8,939	1.02	9,117	40	3,720	1.02	3,794	
Masonry	5	812	.83	674	40	3,720	.83	3,088	
Fireproof					20	1,860	.35	651	
All types	100	16,250		17,266	100	9,300		7,533	
Weighted average volume for region	90			15,539	10			753	16,292
Lakes:									
Frame	60	9,750	1.15	11,212					
Veneer	35	5,688	1.02	5,802	20	1,620	1.02	1,652	
Masonry	5	812	.83	674	60	4,860	.83	4,034	
Fireproof					20	1,620	.35	567	
All types	100	16,250		17,688	100	8,100		6,253	
Weighted average volume for region	80			14,150	20			1,251	15,401
North Central:									
Frame	65	10,563	1.15	12,147					
Veneer	30	4,875	1.02	4,972	20	1,620	1.02	1,652	
Masonry	5	812	.83	674	60	4,860	.83	4,034	
Fireproof					20	1,620	.35	567	
All types	100	16,250		17,793	100	8,100		6,253	
Weighted average volume for region	75			13,345	25			1,563	14,908

[1] State factors are given in the New England and Middle Atlantic regions because of the very considerable difference in proportion of multifamily dwellings in the larger cities of these States. [2] See table 9.

Table 14.—*Derivation of regional and State factors for conversion of dwelling units to board-foot volume of lumber consumed*—Continued

Region and type of construction	1- and 2-family units				Multifamily units				Regional or State factor, all units
	Type distribution	Dwelling volume distribution	Conversion factor [2]	Lumber per average unit	Type distribution	Dwelling volume distribution	Conversion factor [2]	Lumber per average unit	
	Percent	*Cubic feet*	*Board feet*	*Board feet*	*Percent*	*Cubic feet*	*Board feet*	*Board feet*	*Board feet*
South Central:									
Frame	65	10, 563	1. 15	12, 147					
Veneer	30	4, 875	1. 02	4, 972	20	1, 860	1. 02	1, 897	
Masonry	5	812	. 83	674	60	5, 580	. 83	4, 631	
Fireproof					20	1, 860	. 35	651	
All types	100	16, 250		17, 793	100	9, 300		7, 179	
Weighted average volume for region	80			14, 234	20			1, 436	15, 670
Prairie:									
Frame	75	12, 188	1. 15	14, 016					
Veneer	20	3, 250	1. 02	3, 315	20	1, 620	1. 02	1, 652	
Masonry	5	812	. 83	674	60	4, 860	. 83	4, 034	
Fireproof					20	1, 620	. 35	567	
All types	100	16, 250		18, 005	100	8, 100		6, 253	
Weighted average volume for region	90			16, 204	10			625	16, 829
Southwest:									
Frame	70	11, 375	1. 15	13, 081					
Veneer	20	3, 250	1. 02	3, 315	20	1, 860	1. 02	1, 897	
Masonry	10	1, 625	. 83	1, 349	60	5, 580	. 83	4, 631	
Fireproof					20	1, 860	. 35	651	
All types	100	16, 250		17, 745	100	9, 300		7, 179	
Weighted average volume for region	90			15, 970	10			718	16, 688
Northern Rocky Mountain:									
Frame	70	11, 375	1. 15	13, 081	10	930	1. 15	1, 070	
Veneer	30	4, 875	1. 02	4, 972	30	2, 790	1. 02	2, 846	
Masonry					50	4, 650	. 83	3, 860	
Fireproof					10	930	. 35	326	
All types	100	16, 250		18, 053	100	9, 300		8, 102	
Weighted average volume for region	80			14, 442	20			1, 620	16, 062
Central and Southern Rocky Mountain:									
Frame	10	1, 625	1. 15	1, 869					
Veneer	20	3, 250	1. 02	3, 315	10	930	1. 02	949	
Masonry	70	11, 375	. 83	9, 441	70	6, 510	. 83	5, 403	
Fireproof					20	1, 860	. 35	651	
All types	100	16, 250		14, 625	100	9, 300		7, 003	
Weighted average volume for region	85			12, 431	15			1, 050	13, 481
North Pacific:									
Frame	70	11, 375	1. 15	13, 081	10	930	1. 15	1, 070	
Veneer	30	4, 875	1. 02	4, 972	30	2, 790	1. 02	2, 846	
Masonry					50	4, 650	. 83	3, 860	
Fireproof					10	930	. 35	326	
All types	100	16, 250		18, 053	100	9, 300		8, 102	
Weighted average volume for region	80			14, 442	20			1, 620	16, 062
South Pacific:									
Frame	10	1, 500	1. 20	1, 800					
Veneer	90	13, 500	1. 08	14, 580	70	6, 510	1. 08	7, 031	
Masonry					20	1, 860	. 83	1, 544	
Fireproof					10	930	. 35	326	
All types	100	15, 000		16, 380	100	9, 300		8, 901	
Weighted average volume for region	75			12, 285	25			2, 225	14, 510

TABLE 15.—*Estimated lumber requirements for new construction for 3 decades and for alterations and repairs for average decade, by States and regions*

Region and State [1]	Living units required			Lumber required			Alterations and repairs
	1920–29	1930–39	1940–49	1920–29	1930–39	1940–49	
	Thousands	*Thousands*	*Thousands*	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*
New England:							
Maine (17,072)	30	16	32	512	273	546	
New Hampshire (17,072)	18	8	18	307	137	307	
Vermont (17,072)	10	6	12	171	102	205	
Massachusetts (13,945)	193	90	182	2, 691	1, 255	2, 538	
Rhode Island (17,072)	36	16	32	615	273	546	
Connecticut (15,196)	100	49	84	1, 520	745	1, 276	
Regional total	387	185	360	5, 816	2, 785	5, 418	1, 380
Middle Atlantic:							
New York (9,492)	1, 175	466	782	11, 153	4, 423	7, 423	
Pennsylvania (14,442)	451	173	376	6, 513	2, 498	5, 430	
New Jersey (13,204)	330	127	218	4, 357	1, 677	2, 878	
Delaware (14,442)	9	4	9	130	58	130	
Maryland (15,678)	92	42	72	1, 442	658	1, 129	
District of Columbia (10,730)	43	48	28	461	515	300	
Regional total	2, 100	860	1, 485	24, 056	9, 829	17, 290	3, 360
South Atlantic (16,917):							
Virginia	85	40	80	1, 438	677	1, 353	
North Carolina	165	90	145	2, 791	1, 523	2, 453	
South Carolina	70	40	63	1, 184	677	1, 066	
Regional total	320	170	288	5, 413	2, 877	4, 872	700
Southeast (16,917):							
Georgia	84	50	95	1, 421	846	1, 607	
Alabama	86	45	84	1, 455	761	1, 421	
Mississippi	37	18	34	626	305	575	
Louisiana	94	42	75	1, 590	711	1, 269	
Arkansas	48	19	38	812	321	643	
Regional total	349	174	326	5, 904	2, 944	5, 515	900
Florida (16,292): Regional total	171	78	110	2, 786	1, 271	1, 792	220
Lakes (15,401):							
Michigan	390	222	332	6, 006	3, 419	5, 113	
Wisconsin	125	65	107	1, 925	1, 001	1, 648	
Minnesota	75	31	71	1, 155	477	1, 093	
Regional total	590	318	510	9, 086	4, 897	7, 854	1, 300
North Central (14,908):							
Ohio	360	168	291	5, 367	2, 505	4, 338	
Indiana	150	70	115	2, 236	1, 044	1, 714	
Illinois	430	197	329	6, 410	2, 937	4, 904	
Regional total	940	435	735	14, 013	6, 486	10, 956	2, 350
South Central (15,670):							
West Virginia	86	57	104	1, 348	893	1, 630	
Kentucky	95	55	110	1, 488	862	1, 724	
Tennessee	96	50	92	1, 504	784	1, 442	
Missouri	150	49	107	2, 351	768	1, 677	
Regional total	427	211	413	6, 691	3, 307	6, 473	1, 100

[1] Amounts in parentheses are conversion factors from table 14, in board feet per living unit.

Table 15. *Estimated lumber requirements for new construction for 3 decades and for alterations and repairs for average decade, by States and regions*—Continued

Region and State	Living units required 1920–29	Living units required 1930–39	Living units required 1940–49	Lumber required 1920–29	Lumber required 1930–39	Lumber required 1940–49	Alterations and repairs
	Thousands	*Thousands*	*Thousands*	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*
Prairie (16,829):							
North Dakota	15	7	13	252	118	219	
South Dakota	15	6	13	252	101	219	
Iowa	57	19	53	959	320	892	
Nebraska	38	15	32	640	252	539	
Kansas	65	30	57	1,094	505	959	
Regional total	190	77	168	3,197	1,296	2,828	600
Southwest (16,688):							
Texas	328	173	249	5,474	2,887	4,155	
Oklahoma	124	67	96	2,069	1,118	1,602	
Regional total	452	240	345	7,543	4,005	5,757	800
Northern Rocky Mountain (16,062):							
Montana	10	5	8	161	80	128	
Idaho	11	6	9	176	96	145	
Regional total	21	11	17	337	176	273	80
Central and Southern Rocky Mountain (13,481):							
Wyoming	10	4	7	135	54	94	
Utah	27	13	24	364	175	324	
Colorado	33	13	27	445	175	364	
Arizona	29	12	25	391	162	337	
New Mexico	21	10	17	2,283	135	229	
Regional total	120	52	100	1,618	701	1,348	240
North Pacific (16,062):							
Washington	95	31	56	1,526	498	899	
Oregon	75	22	44	1,205	353	707	
Regional total	170	53	100	2,731	851	1,606	380
South Pacific (14,510):							
California	795	335	436	11,535	4,861	6,326	
Nevada	5	1	4	73	15	58	
Regional total	800	336	440	11,608	4,876	6,384	1,000
All regions	7,037	3,200	5,400	100,800	46,301	78,366	14,410

a prospective recovery of residential construction equal to or in excess of the last boom is perhaps a case of the wish being father to the thought. Unemployment has been a serious problem and a revival of construction comparable to that of the last decade would, it is felt, go far toward solving the problem. The analysis suggests, however, that such a construction volume is highly improbable and that, should it be attained, it would be followed by another severe slump unless the normal were raised permanently. Artificial stimulation, if it is to increase construction volume, must increase the normal rate of replacement and not merely change the timing of the cycle or intensify the cyclical changes.

If the family continues to become smaller the same population will require more living units, but this has been going on for over 50 years and is not a new factor. Beyond a certain point, it will

imply a birth rate falling below the death rate, or a declining population. Meanwhile, the size of dwelling is declining and tends to offset the decline in size of family so far as volume of construction is concerned.

The primary factor in the smaller volume of lumber per new living unit now as compared with 30 years ago is the apartment house. Much of apartment-house construction is fireproof, or at least masonry wall. And apartment units average much smaller than single-family dwellings. The trend to apartments was very rapid for a number of years, but is showing signs of leveling off. Logically it would be expected that a point of stability would be reached as between one- and two-family and multifamily construction. Possibly we have about reached that point unless multifamily housing is to occupy a larger place in the low-income class.

Frame construction is holding its own fairly well in one-family dwellings, the most conspicuous exception being the trend to brick and stucco veneer in place of wood outer facing. There are probably two reasons for this trend. One is the recent popularity of the "English" house and the other is an attempt to reduce the painting cost.

It is significant, in a study of lumber used in residential construction, that New England has a higher proportion of all-wood construction than any other region, that the houses in New England average much older than in any other region, and that they are in better average condition. This does not prove wood construction is better than other types, but it is the best illustration of the fact that class of occupancy is a large factor in the life of a dwelling, and also that a wood house can with reasonable care have a life far beyond 100 years and still rate high.

Replacement and Probable Life of Building

THE foregoing estimates of prospective residential construction are based on need growing out of increase in number of families. A replacement allowance is included in the estimates. The fact that it was more or less hypothetical is not yet serious, inasmuch as replacement is still a small part of the total construction volume. This situation is in process of change, and eventually replacements will determine volume of residential construction. Uncertainty as to prospective new housing requirements must increase as this change progresses until we know more about the probable life of dwellings on which to estimate replacements.

Looking beyond the present construction estimates to 1949, a stable population means that replacements must sometime determine volume of residential construction. The forecast of a maximum population of 140 million to be reached by 1960 envisions an increase in families of 280,000 annually at that time, which would drop to zero by 1980. The forecast of a maximum population of 153 million by 1980 supposes an increase of 400,000 families annually as of 1960, dropping to 200,000 by 1980.[1]

If normal residential construction after 1950 is to continue at a level of 450,000 units annual average, the difference between this figure and the increase in families must be made up by replacements. That is, if increase in families is to be at the lower estimate, net replacements (replacements in excess of conversion) must be approximately 170,000 units by 1960 and 450,000 by 1980. The former year is 21 years in the future, but only 1 construction cycle.

Prospective future replacements depend upon prospective life of dwellings, on which there is little information. With 50-year life, replacements should approximate 500,000 annually by 1960; but with 100-year life, replacements will be less than 200,000 annually by 1960.

The Proverbial 50 Years

The age factor is obviously elastic. No law fixes the years that a dwelling can be used for that purpose, or the date when it shall be destroyed. With good care a well-built house can be made to last almost indefinitely, and with poor care or abuse its life may be relatively short. On the other hand, a dwelling may be in good condition and still not suitable for such use because of changed surroundings. Undoubtedly this factor is most apparent during periods of rapid growth and population movement, and such a period constitutes the general experience in this country to date.

From a study of demolition records in the clearing of 936 residential sites in Philadelphia, the Philadelphia Housing Association [2] found:

> Dwelling replacement was a small factor in these demolitions. Only 6 of the sites were cleared for new houses and 16 for tenements; 57 were devoted to manufacturing purposes, 161 were for commercial, 520 for public improvements such as schools and bridge extension, 53 for garages, 104 left clear, and the remainder (19) were for miscellaneous uses. Some gain to better housing came through these demolitions. Thus, 95 back-lot dwellings and 118 houses on unsewered streets were removed. But over 90 percent of the loss in family accommodations was of buildings that still had a long period of usefulness before them.

Sample studies in Washington, D. C., Portland, Oreg., and Oakland, Calif., made for this survey, suggest that the average life of dwellings as estimated under past conditions may not be a safe

[1] These figures are based on estimates published by the National Resources Committee The low estimate assumes medium mortality, low fertility, and no immigration. The higher estimate assumes medium mortality, medium fertility, and no immigration.

[2] KNOW YOUR CITY—DEMOLITIONS OF DWELLINGS IN PHILADELPHIA. Phila. Housing Assoc. Leaflet, 7 pp., 1925.

guide for the future. A check made in 1933 of the sites of 127 dwellings demolished in Washington during 1929 showed only 9 lots still vacant, and occupancy in the others classified as follows:

Present use:	*Dwellings demolished*
Filling stations	42
Apartments	20
Factories	16
Libraries	14
Stores	9
Offices	6
Dwellings	5
Churches	4
Schools	2

The factor of site obsolescence attributable to city growth and commercial expansion is too obvious in these figures to permit the assumption that age of dwellings could have played more than a minor part in the change.

The Portland study covered 328 dwellings demolished in one section of the city during the 12 years from 1920 to 1931. It was possible, from the data obtained, to plot an age curve—in fair accord with curves frequently used in such studies—showing the probable average life of all buildings in the plat to be less than 55 years. It suggests that the generally used estimate of 50 years for the probable life of dwellings originated from similar observations. The evident fact, however, that demolition included several buildings on adjoining lots demolished together representing considerable differences in age, points to site obsolescence and not age as the controlling factor.

The study in Oakland was similar to that in Portland, constituting an analysis of the demolition in a certain area of the city over a period of years rather than in any one year for the entire city. The age curve was practically the same as in the Portland study. In these Oakland data, as given in table 16, the age distribution for buildings demolished is practically the same as that for buildings still in use, indicating that the dwellings demolished came reasonably close to being a fair sample of all dwellings as to age. Here, too, the evidence is rather strong that obsolescence, chiefly site obsolescence, has been more of a factor than age in the demolition of dwellings. The findings in these three cities raise the suspicion that the same condition might be found in other fast-growing cities.

TABLE 16.—*Age distribution of demolished versus standing dwellings, sample section of Oakland, Calif., 1933*

Not over age of (years)—	Dwellings demolished	Dwellings standing
	Percent	*Percent*
20	5	7
30	20	20
40	48	42
50	78	72
60	97	94
70	100	99
80		100

The Real Property Inventory provides some data on age of existing dwellings, and an analysis of such data for some of the older cities suggests a probable life of over 100 years. This seems to justify the fixing of the average life as 80 years, the period required to maintain a volume of construction equal to the estimate for 1930–49—approximately 440,000 units annually. Such a prospective age cannot be criticised as overoptimistic, yet there is no good warrant for setting a lower age figure. It is even conceivable that the current abrupt transition from rapid growth to stable population may retard replacement unduly until we have become adjusted to the change.

Expectations of Shorter Life Doubtful

This approach to probable residential construction for replacements is somewhat at variance with the opinion frequently expressed that replacements will in future maintain volume of residential construction in line with that of the last decade. The opinion springs from the hope for a revival of construction comparable to that of the 1920's to solve the problem of unemployment, and a number of arguments are brought forward to justify it.

One argument is that technological improvements will mean rapid replacement. The future housewife will have fewer servants, and she will therefore demand the sort of house in which there are fewer household tasks and more kilowatts with which to do them. Others argue that radical changes in architecture will encourage replacement of the dwellings we now live in. People will not be satisfied, it is claimed, with outmoded houses any more than with outmoded automobiles. It is also claimed that better transportation will encourage people to move to the suburbs and to the less congested parts of the city, the implication

being that this is a new factor in increasing replacements and one that will work at both ends of the financial scale. Another plausible basis for hope of increased construction rests on the assumption that housing will be subsidized. Here are the particularly appealing arguments that "a third of our population lives in substandard housing," that "houses have never been built for the low-income groups," and that "tapping this field will open a market larger than any before." Closely allied to subsidized housing for low-income families is the prospect of factory-built housing or, more properly, mass production of houses. The assumption is that houses in the future will be designed for quick assembly and with trade-in provisions which will encourage turn-over—something learned from the automobile industry.

Superficially these arguments seem plausible, but they become less so on close analysis. In some respects they are either contradictory one with another, or the arguments supporting them present contradictions. And, contrary to what is perhaps the general feeling in the matter, many of them are not new. Their weaknesses may be more apparent if they are considered in detail.

TECHNOLOGICAL AND ARCHITECTURAL IMPROVEMENTS

Experience with improved equipment of an earlier day, such as central heating, running water, electric lighting, and telephone, tends to contradict the assumption that improvement in equipment will greatly hasten replacement of dwellings. New improvements that can now be proposed—such as air-conditioning, electrical appliances, radio, and television—do not offer as impressive a picture of modernized construction as those gone before. It may be argued, of course, that the older improvements have effected and will continue to effect replacement, but in so doing they have become a part of the past record of construction and hence are included in our experience.

Perhaps the best evidence that the factor of technological and architectural improvement is not new is furnished by a review of old journals. For comparison with the post-war prosperity and building boom of the 1920's it is necessary to go back to the similar period following the Civil War. The following excerpts from a leading builder's journal[3] of that day (1869 to 1874) have a very familiar ring:

> Our cities, north, south, east, and west are displaying their wealth in the astonishing progress of building. The structure which was admired ten years ago is relentlessly torn down to make room for better.
>
> The building space of the city is now being rapidly occupied. Whole streets are created in a year; whole streets of old buildings recreated; great business thoroughfares take the place of whole rows of rookeries.
>
> As this is an age of novelty, no less in building than in other arts and every mind is taxed for new inventions * * *.

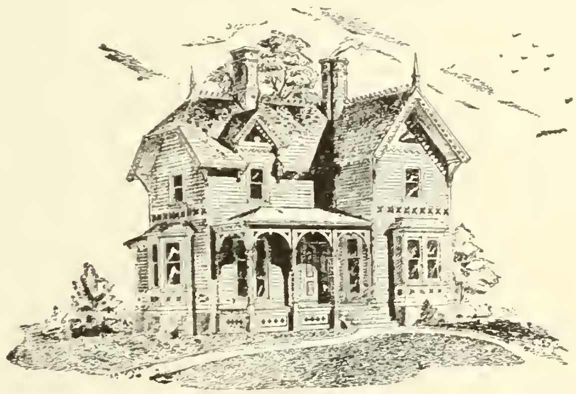

FIGURE 14.—*An up-to-date design (1870) for "one not possessed with an abundance of means."*

> The plan * * * is compact and conveniently arranged, and combines all the modern improvements * * *. The kitchen is so placed that ready access may be had either with the dining room, pantry, or cellar, and is * * * well lighted and thoroughly ventilated. The bedrooms * * * are * * * provided with ample closet room, and all well ventilated * * *.
>
> Every laboring man ought to own his home. The first duty of the working man should be to convert his earnings into real estate * * *.
>
> We propose to give some designs of cottages, the construction of which will range at a figure low enough to enable one not possessed with an abundance of means to take advantage of them (fig. 14). This kind of improvement upon lots newly laid out in villages, at a reasonable distance from the city, would be sure to give an increase to population, and lend character to the place * * *.
>
> Why is our country so full of large, costly, and inconvenient dwelling houses? * * * Those who planned such edifices did not understand the requirements of the occupants * * *.
>
> * * * Its broken sky line (fig. 15) harmonizing well with the natural surroundings, and thus materially increasing the beauty of the landscape * * * instead of marring it, as is too often the case with our country houses, foremost among which is the square, box-like structures to be counted by the hundred in an hour's ride on any one of the railroads going from our city.

[3] Manufacturer and Builder 1: 11, 55, 121, 239, 359; 5: 232; 6: 44. 1869–74.

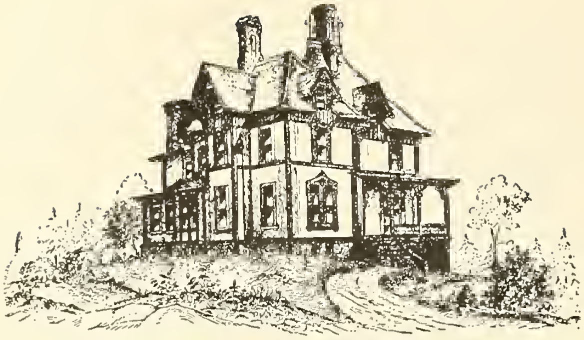

FIGURE 15.—*An architectural novelty of the 70's, with "broken sky line" to replace outmoded "boxlike structures" of colonial design.*

Our architectural series in the present issue are devoted to the interests of mechanics and others who, though subjected to the discouraging pressure of exorbitant rents, by thrifty habits have accumulated a few hundred dollars, and wish, to the end of increasing their facilities for saving as well as adding to their comforts, to devote the hard-earned sum toward securing a house of their own (fig. 16).

These comments sound surprisingly modern to anyone who has followed the trade journals since 1920—the pride in our new structures; the boasting of rapid growth; the appeal of "modern" improvements and convenience; the criticism of old-style, suburban homes recommended for the lower incomes. At one time it may be Fourteenth Street and at another Fifty-second Street, perhaps an English country house instead of a Roman villa, but the fact remains that technological and architectural "improvement" are a familiar part of past experience.

PUBLIC SUBSIDY AND LOW-COST HOUSING

There is the possibility that public subsidy may be an important factor in promoting replacements and so increasing residential construction. It is being advocated in various forms and by various agencies. Experience with past efforts at the allied projects of slum clearance, subsidized housing, zoning regulations, and condemnation to correct bad housing suggests a considerable gap between hope and achievement, but these problems are being attacked more thoroughly and intelligently than ever before and it is reasonable to assume that accomplishments may be greater.

What effect will subsidizing of housing have on the normal volume of residential construction? Subsidizing may be directly effective in slum clearance, in providing better homes for lowest income groups, and indirectly effective in reducing the costs of crime prevention. It may hasten the revival of residential construction by making funds available on better terms than otherwise, or by insuring the value of home investments. But the question pertinent to this analysis is as to the effect on volume of residential construction, particularly the normal or long-range volume as against a mere change in timing or cycle.

Slum clearance, as such, must for several reasons be discounted as a means of increasing normal volume of construction. (1) Although the clearance of a slum is important to the locality concerned, the volume of new construction represented by this factor alone is not large in relation to normal building volume. (2) There has been some slum clearance in the past (the views shown in fig. 17 will refresh the reader's memory), and to that extent it is a part of the past experience which has been used as a basis for estimating probable construction. (3) The better construction and supervision which will probably be introduced with subsidized slum clearance should tend to increase the life of the new structures and to that extent reduce probable future replacements. These considerations suggest strongly that a change in the factor of slum clearance is not likely to have appreciable effect on normal volume of residential construc-

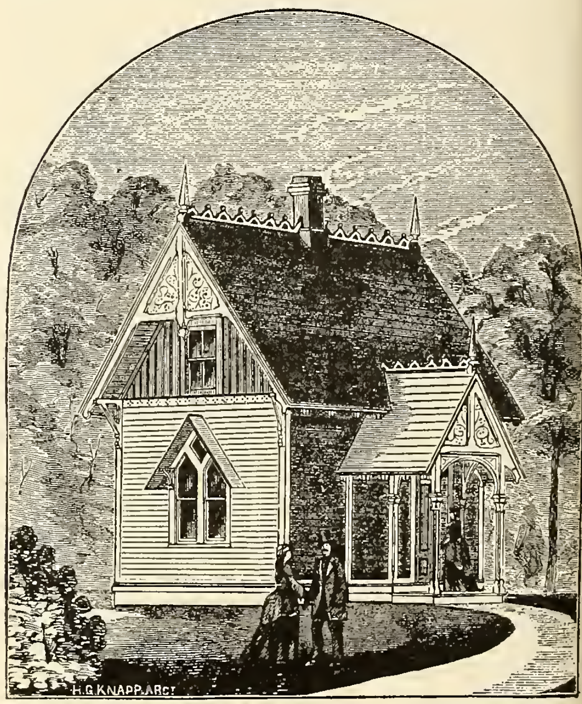

FIGURE 16.—*"Design for a cottage costing $700."*

FIGURE 17.—*Slum clearance is not new—"down by the railroad tracks" in the New York of 30 years ago is now exclusive Park Avenue. Where squalid rookeries hedged in an ugly channel of dirt and noise, now rise exclusive apartments, hotels, and clubs above grass plots and two-lane boulevard. (Courtesy United States Steel Corporation—Photo by Ewing Galloway.)*

tion as represented by past experience, although the effect might be felt for a particular year and for a particular community.

The factor of low-cost housing, better housing for low-income groups, or any general subsidizing of residential construction is another matter, and one on which there is little to base estimates. But again, it is necessary to point out that the question here is not simply whether housing costs can be lowered, or whether a considerable part of our population is living in homes below a desirable standard, or whether subsidizing would hasten the release of pent-up demand; rather the question is to what extent low-cost housing will increase the normal volume of residential construction.

With or without subsidizing, the two major factors in volume of new housing are increase in families and replacement of old houses. The increase in number of families, as earlier set forth, is a combination of increase in population and decrease in persons per family. Subsidized housing will not materially affect increase in population and over a period of time will have little effect on persons per family. It might have some immediate effect under present conditions if it hastened undoubling; but this would be equivalent to a return to a normal that has been assumed in the long-term estimates of dwelling requirements. Even assuming that subsidized housing might mean less doubling up than under normal conditions, it would involve only a small percentage increase in number of families, and similarly a small increase in the later volume of replacements. If total present doubling up were wiped out, it would represent only about 5 percent of all families, and this, though it is an appreciable item in current construction, is not a recurring item.

If subsidizing is to increase future normal volume of residential construction it must bring about total replacement and involve a shorter average life for all dwellings. On this point, concepts of low-cost housing are contradictory. Low-cost housing is not to be "cheap" housing. It presupposes better accommodations for the same income group than those provided in the past, with payments extended over a longer time, and therefore a longer life for the structures. The subsidy will logically carry with it a certain supervision over house maintenance, which will tend also to increase the life of structures.

But the cost of housing cannot be increased without a corresponding increase in income, or it will be reflected in reduced expenditures for food, clothing, health, recreation, etc. Such an experience is recounted in an English journal:

> The M. O. H. for Stockton-on-Tees recently showed how the increased expenditure on rent by ex-slum dwellers in his borough had the effect of reducing the amount of their income available for expenditure on food, and how their health suffered accordingly.

Better housing for the low-income groups must mean better accommodations without increased cost, or the same accommodations at lower cost. But one factor in cost is length of life, and to build better for shorter life makes it more difficult to lower cost.

Even increased income for the lower brackets cannot be allotted to housing arbitrarily. Housing is only one item in the budget; there is also the matter of individual preference. The Lynds [4] in their survey of "Middletown" quote a mother of nine as saying, "We'd rather do without clothes than give up the car"; and another, "I'll go without food before I'll see us give up the car." Competition for the dollar of the low-income groups may mean that instead of better living accommodations, a possible saving in the cost of a home has been and would generally be used for something other than a better house. As it is, figure 18 shows that the low-income groups pay a higher proportion of their incomes for housing than do higher-income groups. The cost of rent as disclosed by the 1933 survey was roughly 15 percent of income for families with incomes from $3,000 to $4,500, 22 percent with incomes from $1,500 to $2,000, and 30 percent with incomes of $750. Some cities show higher percentages and wider ranges than others. A similar relation exists between income and cost of dwelling to owners. The implication is that families in the low brackets must devote too large a proportion of income to housing, and if opportunity presented itself the tendency would be to seek a better balance. That is, first additions to income would be spent on items other than housing.

Disregarding all the social aspects, however, and assuming that subsidized housing might increase the construction of new dwellings for low-income groups, there is still a question as to whether this would increase normal volume of residential construction as measured by past experience.

[4] Lynd, Robert S. and Lynd, Helen Merrell. MIDDLETOWN, A STUDY OF CONTEMPORARY AMERICAN CULTURE. 550 pp. New York. 1929.

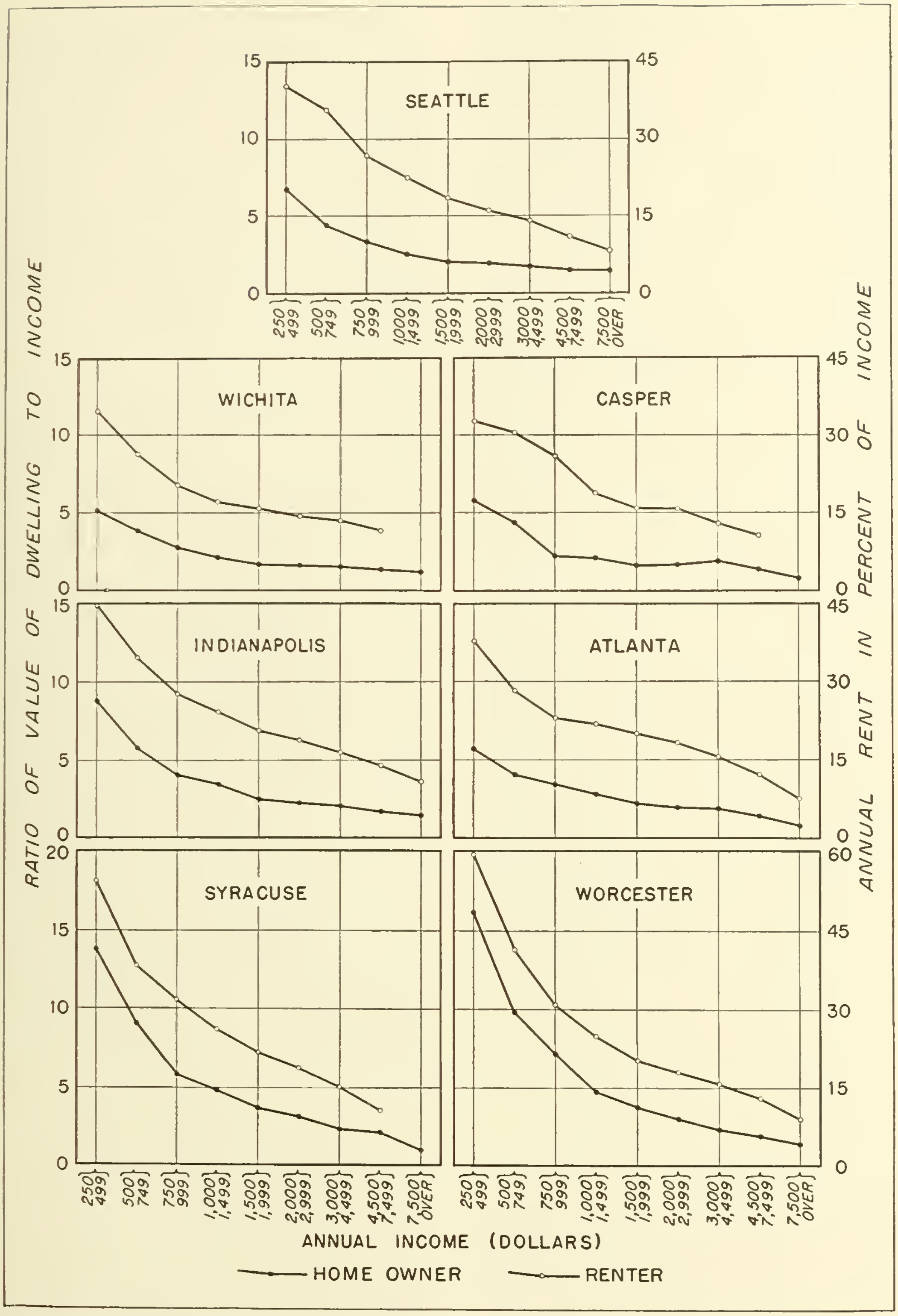

FIGURE 18.—*Ratio of income to expenditure for housing in seven representative cities in 1933, in owned homes and for rentals.* (WICKENS, DAVID L. FINANCIAL SURVEY OF URBAN HOUSING. *U. S. Bur. of Foreign and Dom. Com- 1,245 pp. 1937.*)

A study of the effect of public housing enterprise upon private building made by Woodbury,[5] while admittedly covering a very limited experience, is suggestive. He compares construction recovery in 35 cities which had P. W. A. housing projects in 1936 with similar recovery in 66 cities without public housing construction. His comparison is as follows:

During the first ten months of 1935, in these same cities [35 cities destined to have PWA housing projects in 1936], 28,630 families were provided for in newly constructed residential buildings in comparison with 60,791 family units during the same period last year. The increase measured by this unit was 112 percent * * *. In these nonPWA cities (66 cities of the same size class) private builders from January to November 1935 provided new units for 11,516 families in comparison with 25,079 for last year. This increase was 118 percent.

Public enterprise apparently had little effect on total volume of residential construction; relative increase in construction was actually a little higher for the non-P. W. A. than for the P. W. A. cities.

With rapid increase in population there has been continual shifting—higher-income groups moving away from commercial areas and traffic arteries, giving way to lower-income groups. There is no doubt at all times a tendency to pass the older dwellings down from group to group, but this tendency is accelerated in a shifting population so that old dwellings have in the past been handed down at an earlier age than would be the case if the population were stable. The action is cumulative, in that such change of occupancy means more rapid obsolescence and passing on to still lower income groups. That type of occupancy is a major factor in the life of a structure can be seen by comparison of residential areas of the same original type, one of which has changed in occupancy class and the other has not.

With increase in population approaching the zero point, change of occupancy slows down materially. Instances can be found in many cities where there has even been a return to original occupancy class, resulting in restoration of the old dwellings. Not only do dwellings suffer less abuse with continuous high-class occupancy, but there is less likelihood of a family in the upper brackets replacing an old house with a new one on the same site; they more often wish to dispose of the old property for other occupancy and build on a new site. Consequently, a stable population may mean longer life and lower rate of replacement in the upper groups. Fewer houses will be handed down and fewer razed. If this involves a larger proportion of new units being built for the lower-income groups—in which subsidizing will be helpful and necessary—such construction will not necessarily mean a larger volume of construction than would be estimated from past experience. If it is a matter of building one new dwelling, the volume of construction is greater in the dwelling at the top of the scale than in that at the bottom.

MASS PRODUCTION

The hypothesis that the building of low-cost homes for the low-income families will materially increase normal volume of construction has led to the assumption that mass production is the solution to the housing problem. Construction labor is a large item in the cost of building a house. Mass production applied to housing as it is applied to automobiles would, it is assumed, bring about substantial savings, particularly in the lower brackets, thereby broadening the market for new dwellings.

There seem, however, to be some fundamental difficulties in applying mass production to housing. The principle of mass production may be the same in both cases, but the house and the automobile have between them more contrarieties than similarities. One is built for long life, the other for short life. One requires time to give maximum satisfaction, the other starts at maximum. Improvements are readily made to one; improvements in the other mean replacement. Moving to a new house may mean an irretrievable loss in the disrupting of old friendships, whereas driving a new model into the garage is a joyful experience.

Mass production reduced the cost of a motor vehicle from $2,000 in 1908 to $500 in 1928 and increased the number of automobiles on the road from 200,000 to 25,000,000. There is, however, no prospect of a similar development in housing. Mass production of automobiles began when few families had one, whereas mass production of housing would start with every family in a dwelling. If under really comparable conditions, wherein every family had both an automobile and a dwelling, it could be said that a reduction of 20 percent in the cost of a new automobile would mean shorter life and earlier replacement, then it might be reasoned—although the reasoning is questionable—

[5] Woodbury, Coleman. integrating private and public enterprise in housing. Amer. Assoc. Polit. and Soc. Sci. Ann. 190: 162–175. 1937.

that a similar reduction in the cost of a house would similarly increase replacements.

If mass production of houses is to be factory production, it is inconsistent with the current theory of increasing employment through the breaking down of centralized industry into small units. Factory production of houses would stimulate centralization in the one major industry which has remained decentralized. Possibly there is an alternative to centralization as a method of reducing costs in the industry. Some 2,400 trade-labor hours, 60 man-weeks, are required to build a house. At $1.25 per hour the trade-labor cost is $3,000, or about $2,500 per man-year. On the other hand, the trade laborer works only part time and earns, say $1,500 per year. If he would give a year's work for these yearly earnings the charge against the house would be only $1,800 instead of $3,000. The trade laborer would earn as much as he does now, and the threat of factory production would be farther away.

If mass production of houses is to be regarded as an objective in itself, it is likely to involve some inconsistencies. Lumber has been and still is the primary material for construction of houses because of its low cost and adaptability. Attempts at mass production with other materials have thus far been unsuccessful in meeting the low cost of lumber, and as the search continues there is a tendency to look upon mass production as desirable for itself; that is, the search is by way of being considered successful if mass production achieves a house cost comparable to that which we already have.

Once this is clearly appreciated, another solution to slum clearance which might have a perceptible effect on construction suggests itself. Slum-clearance projects get their support from a commendable desire to improve the living conditions of people in the slums, and also a desire to clean up the blight on the area involved. Rebuilding on the site has tended to make costs excessive for the slum dwellers, or has increased the density of population by providing for more families than previously occupied the site. The slum is as much a matter of congestion as of poor buildings. If the slum dwellers can be moved out of congested areas it makes possible the use of frame construction for good housing at low cost. Fireproof construction in congested areas means making congestion permanent.

This discussion of replacements is not intended as a criticism of subsidized housing, of slum clearance, of research for low-cost housing, of attempts to improve dwellings, or of any such activities in housing. The purpose is to show that, regardless of justification for these activities and the benefits to be derived from them in other respects, they may not and probably will not appreciably affect volume of construction estimates as arrived at here. This opinion is further supported by European experience.

European Experience

It seems necessary to include in this survey a résumé of European experience, for two reasons: (1) There is a general belief that dwelling construction in European countries, particularly in England and Germany, has been much greater relatively than in the United States, and that this greater volume of construction is the result of subsidy. (2) The suggestion is frequently made that European countries have gone much farther than we have in developing new methods of construction, implying notable results therefrom and the same possibilities here.

The general belief that European countries have enjoyed a larger building boom than has the United States rests on comparisons made for the period after 1929. Comparisons for such short periods are always open to question, and are certainly misleading in the present case, as is readily apparent from table 17. The United States, it will be noted, built more than five times as many new dwelling units as did England from 1919 to 1929. Construction in England did not reach its largest volume until after 1930, or after our boom was over. In the whole after-war period, the United States built three times as many new units as did England. On a per capita basis, construction volume was about equal in the two countries.

TABLE 17.—*Comparison of construction volume in relation to population, United States, Germany, and England* [1]

Country	Dwelling units constructed			Comparative populations, 1930
	1919–29	1930–35	1919–35	
United States	7,500,000	800,000	8,300,000	129,000,000
Germany	2,400,000	1,200,000	3,600,000	62,000,000
England	1,400,000	1,400,000	2,800,000	40,000,000

[1] The United States figures are for new construction. The German figures include units provided by conversion, which make up 15 percent of the total. The figures for England are presumably for new construction.

Obviously the picture is quite distorted when comparison is made only for the period most favorable to one or the other country. Incidentally, reports from England indicate that a recession is expected from its 1930–36 rate of construction, and this just as we are anticipating another recovery. The difference seems to be largely a matter of timing of the construction cycles.

The building boom in Germany was a little slower getting started than our own. It did not go as high and the reaction was not as great. Relatively, the volume for the entire period is slightly less than for the United States, but the difference is increased when the converted units are subtracted from the German figures. United States figures include only new construction, whereas 15 percent of Germany's additional units were provided by conversion of larger units to smaller ones.

There may be similar distortions in the view that a revolution in construction methods abroad has been effective in reviving the industry and that a similar overturn of building methods is the solution to our own problem. At least one report,[6] based on an actual survey of European experience, presents a somewhat different view, summarized as follows:

The stage of post-war Europe was ready set for a positive advance in the technology and rationalization of house-production. Whole neighborhoods, even whole towns, were to be planned as a unit and constructed all at once. Large-scale methods were to be applied throughout. Costs had to be reduced. Many governments, in order to safeguard their enormous housing investments, set up impressive agencies for the sole purpose of making investigations and experiments in new materials and new methods. Hundreds of architects were convinced that the old building ways were obsolete, and that new forms must be devised to facilitate a modern solution.

And yet, insofar as the general run of housing construction is concerned, one could hardly say that any very revolutionary change had been made. During the emergency, England tried any number of methods of using steel and concrete. But for the past 10 years almost every new house has been made of ordinary old-fashioned bricks, laid in traditional hollow masonry walls, and has had a roof of either tile or slate. There are plenty of figures to show that these are still the cheapest houses the English are able to build.

The public authorities of Amsterdam, around 1924, erected an entire village of concrete. Forty different systems were tested, and about ten tried out on a large scale—including poured concrete, prefabricated concrete walls or parts of walls, and concrete blocks made on the job. Small houses for thousands of families, and also schools, shops, public buildings, and clubs, were put up. An enthusiastic report was published, to describe the economies thus effected. And yet all the recent housing in Amsterdam has been built of brick, by the usual traditional methods.

Probably the most complete experiment was made in Frankfurt. There a government institute with the aid of the University conducted an exhaustive research into the possibilities of concrete. At length the local authorities decided to use large precast concrete units, measuring approximately 10 feet by 3.5 feet by 6.5 inches. The aggregate was slightly vulcanized lava—or pumice stone—found in the neighboring Rhine Valley, a very porous light rock with strong insulating qualities. Two factories were set up to make these units. A special small derrick was designed and manufactured to set the plates in place on the job. Houses were designed on the basis of these units, and several thousands of them were soon constructed. There were many obvious advantages. Much of the production was done in the factories, thus reducing the weather gamble. And eighteen men could put up the shell of a two-story house, including cellar and floors, in a day and a half, or 230 hours of labor all together. The insulation, after the outside was stuccoed, was one hundred percent better than in a brick house. It was officially estimated that the cost per unit of wall area was about ten percent less by the new concrete method than by the old brick one. And yet, again, of recent years most of the new dwellings have been made of brick.

Poured concrete has been tried on a large scale in many places in Germany. At Dessau, Mr. Gropius' Törten development has concrete party walls and floors, the front and back walls being filled in with brick or hollow tile. Many new covering materials were used over wood or steel frames by the different architects of Weissenhof, the exhibition housing-development built at Stuttgart in 1927. And the general use of light steel frames for apartment buildings, occasionally for small houses as well, made considerable headway in Germany up to 1932. Haesler's Rothenberg development at Kassel is probably one of the most interesting new housing constructions in Europe, structurally as well as in exterior and interior plan. But today in Germany they are no longer advancing the use of steel or concrete or new insulating materials or prefabricated parts.

At the Stockholm Exhibition of 1930, there were dozens of full-size houses and apartments, all of experimental design and construction. A hundred different new materials were exhibited and tried out. But the only kind of building which has so far really been rationalized in general practice in Scandinavia is wood construction for small suburban or country cottages.

The logical deduction from such observations is that revolutionary change in the building of houses has not held its ground in European countries, either in rate of replacement or in methods of construction. This is not an argument for or against the desirability of change, but a confirmation of the general conclusion that departure from long-established housing economy is not normally to be expected and is not easily accomplished by arbitrary stimulation.

[6] Bauer, Catherine. modern housing. 331 pp., illus. Boston and New York. 1934.

Summary

THE consumption of lumber for residential construction is determined by number of living units built and lumber per unit. Number of units has borne a direct relation to increase in number of families for 75 years. During these years, this factor has obscured the much smaller one of replacements due to wear and tear, obsolescence, clearing of blighted areas, fire, etc. At present, however, the country has entered upon a transition period. Rate of increase in families is slowing down and will tend toward stability. On the other hand, the factor of age of existing dwellings has not yet had time to develop fully. As it increases, replacements should increase.

As a result of the survey covered in this publication, the conclusion is reached that future normal volume of residential construction should be about 4,500,000 units per decade with the decade 1930–39 falling below that figure and decade 1940–49 going above it. Replacements should hold that volume eventually. This is about the volume of construction prior to 1920 but considerably below the 1920–29 volume. Looking farther into the future, it is reasonable to expect that replacements will eventually approximate 450,000 living units annually; that is, 450,000 living units may be a prospective normal even after population reaches stability.

Much attention is being paid at present to finding ways and means of increasing residential construction. This is not a new factor, but is more or less a part of the normal experience. Undoubtedly, interest in the subject is more intense now than at any time in the past, and this may have its effect. The fact is, however, that housing is one of four or five major items in the cost of living, and except as income increases, the expenditure for one item cannot be increased for the great majority of families without taking from another. The constantly increasing competition for the wage earner's dollar makes it difficult for housing to hold its share. Lower costs may make possible a larger dwelling unit for a given expenditure. The trend is actually to smaller units as the average family grows smaller.

Emphasis is being given to low-cost housing with a view to providing a larger proportion of new housing for the lower-income families. As population approaches stability, there is likely to be less of that shifting which in the past has meant the handing down of houses from a higher-income group to a lower. If the process is slowed down, then new houses must be distributed more evenly to all income groups. But building a larger proportion of houses for the lower incomes does not mean increased volume of construction except as it involves a shorter useful life for all housing.

Whereas the requirement for new housing can be definitely related to increase in number of families and a normal life for existing dwellings, the demand or actual construction moves in cycles with wide fluctuations above and below the normal requirement. The cyclical period is shown to be about 18 years, but fluctuation from normal is a matter of current conditions and can only be charted in advance on the assumption of some similarity to previous cycles. A pattern has been suggested for the cycle ending about 1950. The last half of 1937 lagged behind the pattern, and presages a movement later above the pattern unless the total for the period is to fall below the total estimated per decade.

Lumber per living unit has declined appreciably in the last 30 years, owing largely to the development of multifamily housing of masonry and fireproof construction. This is not, strictly speaking, a substitution of other materials for lumber, because large multifamily structures of lumber are out of the question. Nor is the effect quite the same. We are apparently approaching a balance between one- and two-family housing and multifamily housing, and to that extent the factor is discounted. Displacement of lumber in one- and two-family housing would, on the other hand, suggest a continuation of the trend. So far such a trend is not very marked. Masonry construction in this field

is much the same as in the past. There has been a noticeable trend to brick and stucco over frame, but lumber exterior face makes up only some 10 percent of the total lumber in an all-wood house, and a partial substitution of other materials has not greatly reduced the lumber per unit.

The analysis arrives at a prospective average annual requirement of 6.4 billion board feet of lumber for new residential construction and 1.4 billion board feet for repairs per annum. These estimates are based on the volume for a decade, and cannot be applied to any one year. An estimate year by year can be arrived at by applying the lumber per unit to the suggested construction cycle.

The effort has been made throughout to analyze the various factors separately, so that correction or revision of the estimates can be made for any factor at variance with the analysis.

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